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MR. HAYWOOD'S FIFTEEN INCH RAILWAY.

AT Duffield Bank, not far from Derby, Mr. Percival Haywood, a gentleman of independent fortune, has constructed a narrow gauge railway, which engineers visiting the Royal Agricultural Society's Show will do well to see. The following description of this little line has been prepared by Mr. Haywood, and we illustrate the engines from drawings with which he has supplied us.

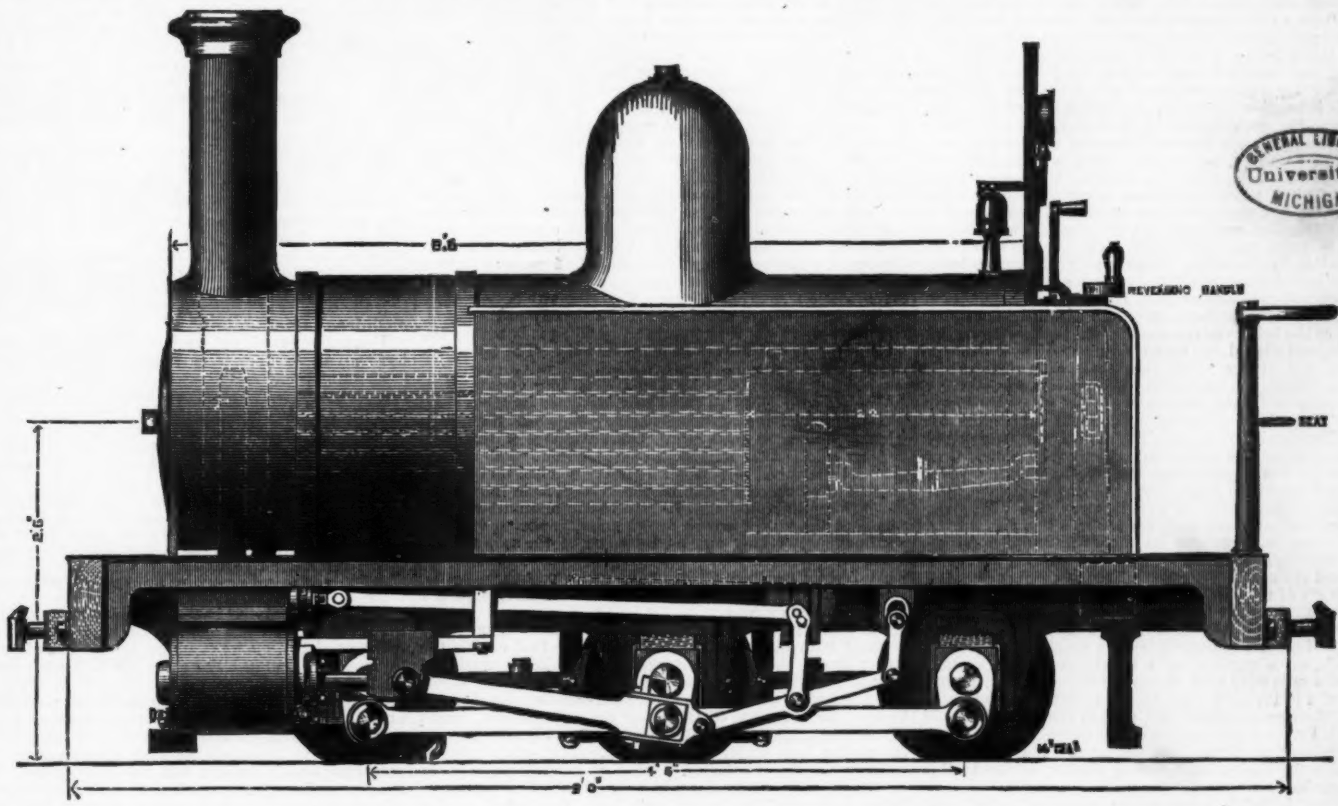
OBJECTS OF THE RAILWAY.

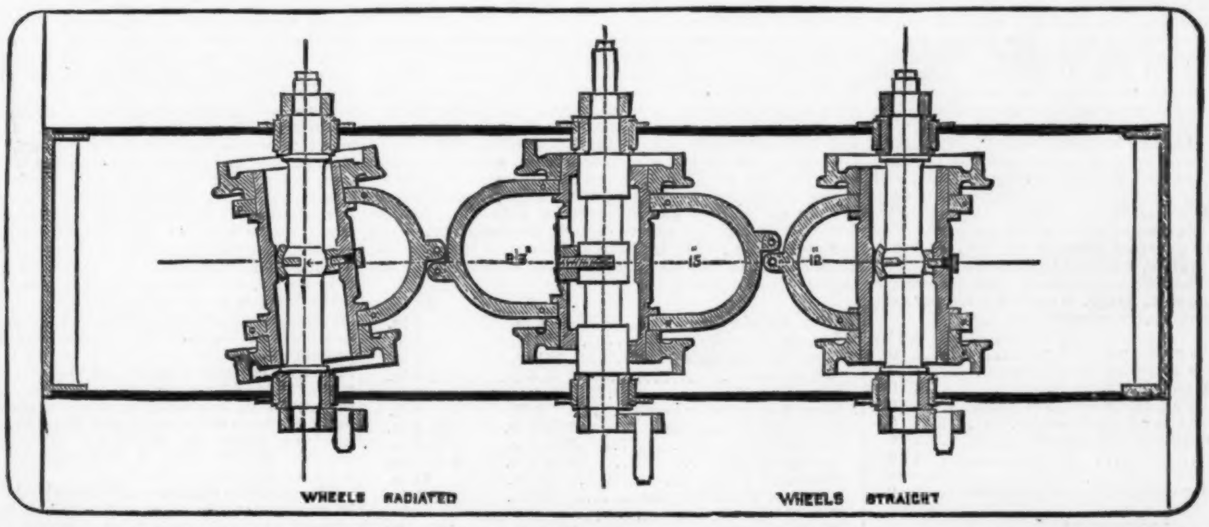
This paper does not pretend to discuss the whole subject of light narrow gauge railways, but is merely a short account of the writer's experimental line, with such notes as when unhampered by persons riding upon the wagons, but man being an article of standard size, it is clear that there is a minimum gauge which will with safety resist his attacks in the shape of sitting on the edges of wagons, and so on. Rolling stock properly proportioned to a 15 in. gauge seems as small as will insure safety in this respect and, indeed, in France, M. Decauville has arrived at nearly similar conclusions in constructing a minimum gauge of 16 in. The writer must not be understood to advocate gauges so small as these, except where the traffic is unlikely to increase beyond the capacity of such a line, and where the material to be moved can conveniently be loaded in little wagons; his object in adopting it for experiment was to see how capacious the rolling stock could safely be made on a given gauge, without being at the present time about a mile; of which half is arranged in the form of a pair of spectacles, to admit of a continuous run. The maximum gradients on this part are 1 in 25, and the minimum curves half-a-chain.

During the last year a six-coupled locomotive, with radial axles for traversing sharp curves, has been built, and also a closed bogie carriage to hold sixteen persons. The writer is always glad to show the railway to any who are interested in the subject, and also to give information as to experiments that have been carried out, and of the cost of the various modes of construction.

CONSTRUCTION OF THE LINE.

The line, of 15 in. gauge, was at first constructed to carry





MR. HAYWOOD'S FIFTEEN INCH RAILWAY.—THE LOCOMOTIVE USED THEREON.

may possibly be of use to those interested in gauges of 2 ft. or under. It is hardly at the present day necessary, as it would have been when this line was first constructed, to offer an apology for considering such miniature railways as something more than toys. Their quickly increasing popularity during the last few years is sufficient acknowledgment of their utility under suitable conditions. In the year 1874, the writer, after various preliminary trials, determined to construct a model railway of 15 in. gauge, no less size appearing to offer sufficient stability for practical use, although a 9 in. gauge has been built for some friends as a toy; the wagons being 3 ft. by 1½ ft. inside, and the passenger carriages admitting one on each seat.

The stability of this very small line is perfect enough incurring the expense of large and unwieldy wagons. It was, however, not only to acquire this information that the railway was constructed, but to experiment on various questions connected with friction and resistance, and also on the roadway and appliances necessary for a serviceable Army Field Railway plant.

A certain length of line having been finished, a locomotive, carriages, and wagons were built in the writer's amateur workships, and experiments carried out during several years. Later, the line was extended and developed, and a long timber viaduct erected in connection with a scheme for military railway. The workshops, situated 70 ft. below, were connected with a line by a branch having a gradient of 1 in 10; the total length of the whole, including sidings, loads of half a ton per axle, and laid with 14 lb. iron rails, without fish-plates, the sleepers being 5 in. by 2 in., and 2 ft. 6 in. long, spaced 18 in. center to center. The whole was carefully laid and ballasted; but the result was not satisfactory, as sleepers frequently required repacking. A part, and eventually the whole of the main line, was then relaid with various weights of both iron and steel rails, from 9 lb. up to 22 lb. per yard, and sleepers 6 in. to 8 in. wide, 2½ in. deep, and 3 ft. long. The sleepers were tried both at 18 in. and 2 ft. apart, and all rails were fish-jointed, the joints being on a sleeper.

In every case the new road proved far better than the old, the improvement being entirely due to the fish-plates and longer sleepers. Part of the road laid with 12 lb. steel rails,

and sleepers 2 ft. apart, has not been touched since first put down five years ago, although constantly run over. The writer has for some time been of opinion that a sleeper rather more than double the gauge in length will be found to give the best results, if the depth is sufficient to avoid bending.

Mr. Spooner has used 4 ft. 6 in. sleepers on the 2 ft. gauge Festiniog Railway with the best results; and if the strain be examined it will easily be seen why this is so. Unless the sleepers are more firmly supported outside the rails than between them, the traffic will cause the ballast to become convex lengthwise of the sleepers, and so make the road unstable; and by a very simple calculation it will be found that a length approximating to two and a half times the gauge will be required in order to make the sleepers sink evenly. When this is the case, and the packing has been properly done, the road, if the formation be sound, will be long before it works loose.

Good fish-plates are a *sine qua non*, and with the ordinary flat-bottomed rail the joints are best on a good broad sleeper; they should also be as nearly as possible opposite one another, for which object it is a good plan to order a proportion of rails 3 in. shorter than the standard length, then, as soon as one rail lags as much as 1½ in. behind, a short rail should be laid on the opposite side. The writer tried "breaking joint," with the most uncomfortable results. The joints will sink, and if opposite one another, the serious jolt which is felt in running over a bad joint on one side only is avoided. The rails are bent before being laid by passing them under a screw which stands between a couple of rollers; but the writer designed a simple form of rail bender, on the principle of a tire bender, for the Royal Engineer Department to use on their field railways, by which the rail was continuously bent while being drawn through the rollers. With a little practice, however, rails may be sprung round sharpish curves without any bending; but great care must be taken to screw up the fish-plates very tight before springing, and to avoid overstraining the joint, which will produce a "dog leg," not to be got rid of without the "jim crow." It is needless to enter into a description of the points and signals, the peculiarities in these having to do rather with full-sized railways than with those of narrow gauge.

The timber viaduct, before referred to, is 91 ft. long, and varies from 12 ft. to 21 ft. in height. It is constructed entirely of pitch pine, the trestles being so designed that each member is a multiple of the height. The roadway is carried on four timbers, each 11 in. deep by 3 in. wide, bolted together in pairs, one pair under each rail, the two being kept parallel by stretchers. In each pair the timbers break joint with one another on alternate trestles, the latter being 15 ft. apart and each timber 30 ft. long. The advantages of this are twofold: the timbers can be run forward from trestle to trestle as the bridge advances, without scaffolding or lifting tackle, and should one trestle sink out of line, the continuity of the upper work checks it, and obviates the dangerous elbows so common in similar structures.

The total cost of the viaduct was £30, or under £1 per yard, the strength being amply sufficient to carry a six ton engine. The details are arranged to require but little skilled labor, the connections being made chiefly with bolts. Two carpenters in five days framed the five trestles, including cutting the timbers to length; and in three more days, with the additional assistance of two laborers, the whole was erected and the rails laid ready for traffic. The viaduct was designed as an improvement on the form adopted for the military railways at Aldershot and Chatham, as being simpler and stronger.

The length of the part of the line used for experiments is, as before stated, about half-a-mile, and although there are gradients of 1 in 25, a more trying bit for the engine is a curve of half-a-chain radius, embracing nearly three-quarters of a circle, on a gradient of 1 in 50. A branch about a quarter of a mile long leads down to the workshops, with a gradient of 1 in 10; up this the locomotives haul rather more than half their own weight; this, though fairly good, would be exceeded were it not for two severe curves, which, on so steep a gradient, are formidable obstacles. This part of the line crosses the fences on balks of timber, an excavation being made below to prevent the passage of cattle.

The ballast is chiefly ashes, which, when to be had, will be found to remain porous far longer than gravel, and also to produce very little dust, and that less injurious to the engines than ballast containing sand. The sleepers are all elm and Spanish chestnut, fallen and sawn on the premises, and worth from 7d. to 8d. each. Ordinary dog spikes are used, four to each sleeper, in securing the rails; great care requires to be observed in procuring these spikes of first-class quality.

With the assistance of two laborers, the writer has usually laid about thirty yards per day, which includes bringing forward rails, sleepers, and ballast; bending, spiking, and fishing rails; packing sleepers, top ballasting, and dressing off; equal to about 5d. per yard for labor. The materials, with 12 lb. steel rails, costing about 4s. 6d. per yard. The line, when laid, costs therefore about 5s. per yard, exclusive of earthworks and bridges, which in this case average about 3s. per yard run. The following estimate gives the cost per yard of a line about 15 in. gauge, to carry one ton per axle, allowing an ample margin for emergencies:

	s.	d.
Earthwork, 2 cube yards, per yard run	2	0
Bridges, and other structural works, say	1	0
Rails, 18 lb. steel, including fish-plates	3	0
Sleepers, 7½ in. by 2½ in. by 3 ft., 2 ft. apart	1	0
Ballast, 1 cube yard, per 3 yards run	1	0
Laying (including points) and spikes	1	0
Extras, say	1	0
Cost of 15 in. gauge surface line, per yard run	10	0

LOCOMOTIVES.

The two locomotives now on the line were designed with different objects. The first, an outside cylinder four-wheeled tank engine, put to work in 1875, was intended to be as handy, compact, and cheap as possible. In building it, a good deal of material which happened to be at hand was used rather to the prejudice of appearance to save expense; it has, however, run about 3,000 miles with none but trifling repairs, and has proved itself pleasant to handle in every way. This locomotive has four steel-tired wheels, all coupled, 15½ in. diameter, with a wheel base of 2 ft. 6 in., and an overhang at each end of 2 ft. 3 in. The boiler is a simple cylinder, with ends suitably shaped for attachment to the frame, and contains a cylindrical fire-box, in the form of a short flue, terminating in tubes.

The absence of any projecting fire-box admits of the engine being perfectly balanced on the axles, and such a boiler, while capable of making as much steam as is required, is not only cheaper in first costs and repairs, but much safer, when placed in the hands of comparatively inexperienced men, than an ordinary fire-box boiler, and also far easier to clean. The springs are rubber blocks, fitted into the hornblocks above the axle-boxes. It is always asserted that oil destroys india rubber, but this is not practically true as regards the very best quality. The blocks in question have been moist with oil for six years, and are as good and elastic as when first put in, the sole sign of decay being an almost imperceptible rounding of the edges.

The only other peculiarity worth notice is the plan of allowing the connecting rod brasses to turn in their straps. These latter are bored, instead of slotted out, in the direction of the length of the rod, the brasses being shaped circular to fit. This enables the latter to accommodate themselves to the varying transverse parallelism between the axles and the frames, due to the unequal rise and fall of the springs on opposite sides, thus avoiding all twist on the slidebars, the cutting of which was a constant source of annoyance till the above plan was tried.

The maximum speed attained over a measured course, taken with a stop watch and checked by a revolution indicator, is twenty three miles an hour, the motion at that speed being perfectly steady. With a tender attached, continuous runs of an hour have frequently been made at an average speed of ten to eleven miles an hour, the rate on the straighter parts of the line being fifteen to eighteen miles an hour, reduced to seven or eight on the sharp curves. The writer considers that on any gauge the maximum speed, if the road be good, may be as many miles an hour as the gauge is inches wide, and half this for goods traffic. The rule, however, does not at present apply to gauges over 5 ft.

The second locomotive, constructed by the writer, was designed as an engine suitable for military railways, to afford great power on a narrow gauge, and able to take very sharp curves, at the same time avoiding the complication of the double bogie system, without making the weight on each axle too great. This engine has six cast steel wheels, all coupled, each pair of wheels being keyed on a hollow axle, within which are axles coupled at their outer ends by cranks and coupling rods in the usual way, and running in ordinary bearings. The middle hollow axle is capable of sliding laterally on its inner axle, but cannot revolve on it. The leading and trailing hollow axles are internally larger than their inner axles, to which each is connected by a central ball and socket joint, so arranged as to leave the hollow axles free to radiate in any direction, but compelling them to revolve with the inner axles. The middle hollow axle is connected with the leading and trailing hollow axles by iron straps and links, so designed that when it slides laterally, as is the case on entering a curve, the other two hollow axles with their respective wheels are radiated truly to the curve, no matter what may be its radius, providing it is within the limit of the lateral travel of the center axle. The space between the frames being thus occupied, the valve gearing is necessarily outside; and to avoid overhung eccentrics, a modification of Brown's valve gear, designed by the writer, is adopted, the arrangement being somewhat similar to what is known as Joy's gear. One advantage of this type of valve gear is that it gives a constant lead, whatever the travel of the valve, so that when closely notched up the diagram is not distorted by an increased lead, as in the case of the ordinary link motion. To give the minimum strain on this gear, the valves, which are circular, are balanced by a packing ring working against the cover of the steam chest, a pin-hole being drilled through into the exhaust cavity of the valve, by which any leakage of steam past the packing ring, which otherwise would destroy the balance, is passed away with the exhaust.

The boiler is similar to that already described. The engine is fitted with only a steam brake. In the first engine the writer found the ordinary screw hand brake so much too slow in action for such sharp curves, that a tender, subsequently built, was fitted with an instantaneous friction brake. From the use of the latter the advantage of quick action was so apparent that a steam brake only was fitted to the engine now under consideration. The safety valve is entirely within the boiler, so that it cannot possibly be tampered with. The draught through the lower rows of tubes is insured by a petticoat pipe somewhat on the American plan in the smoke-box, which also acts in a measure as a spark arrester.

There are various other details of peculiar design, but they are of little practical importance, and will, therefore, not be mentioned. Two exceptions will be taken to this engine. First, that the motion is too near the ground; secondly, that there is too liberal a use of cast iron. The answer to the former is that the engine is almost too large for the gauge, and it was necessary to keep the center of gravity low; to the latter, that the writer is an indifferent smith, but a fair moulder. He would not, however, advocate this type of engine except for special purposes. Four-wheeled simple engines are the best and cheapest for light lines, and, no doubt, if makers had orders enough, they might turn out these with 4 in., 5 in., and 6 in. cylinders, as low as £200, £300, and £400. Annexed are given the dimensions of the engines above described:

	No. 1.	No. 2.
Diameter of cylinders	4 in.	5 in.
Length of stroke	6 in.	7 in.
Diameter of wheels	15½ in.	14 in.
Wheel base	2 ft. 6 in.	4 ft. 6 in.
No. of wheels	4	6
Length over buffer planks	7 ft.	9 ft.
Overhang at each end	2 ft. 3 in.	2 ft. 3 in.
Width over	2 ft. 3 in.	3 ft. 9 in.
Length of boiler	4 ft. 6 in.	6 ft. 6 in.
Diameter of ditto	22 in.	24 in.
Diameter of fire box flue	11 in.	14½ in.
No. of tubes (1¼ in.)	23	42
Heating surface	23 sq. ft.	56 sq. ft.
Grate area	1¼ sq. ft.	2 sq. ft.
Weight in working order	1 ton 3 cwt.	2 ton 10 cwt.
Working pressure	125 lb.	150 lb.
Net tractive power	500 lb.	1,200 lb.

As regards the heating surface, it will be noticed that that of the lesser engine is very small. This was owing to faults in the design, as it might easily have been considerably more without enlarging the boiler. This engine has, however, frequently run for an hour continuously with a train, and kept steam well; but the following will be found a good rule for proportioning the heating surface of such engines: Multiply the diameter of the cylinder by the stroke, both in inches; twice the result will be an ample number of square feet of heating surface. Once and a half will do very well for ordinary purposes. Any difficulty in getting up steam may be obviated by a few feet of stove pipe inserted in the chimney.

WAGONS AND CARRIAGES.

The wagons at first built for the line held only eight cubic feet, and have been replaced by others of larger size. The present ones measure 2 ft. 6 in. by 5 ft. inside; the sides are framed together independently of the wagon itself, which is constructed flat, with a rim 1 in. high. The sides, or "tops," as the men call them, are about 1 ft. deep, and the wagons can be used either with or without them; and being interchangeable, any number of tops can be put on to one wagon to make it of the desired depth. To empty the wagons the tops can be easily removed. The weight of the wagons varies from 4 cwt. to 5 cwt., and they are constructed to carry a maximum weight of 2 tons, 15 cwt. to 1 ton being the usual load.

To show the capacity of the gauge, one wagon was built 6 ft. long, which will hold 30 cwt. of soil or sand, but it is found less convenient than the smaller ones; so far as stability is concerned, however, 6 ft. by 3 ft. would be quite admissible. The rule of Mr. Spooner, of the Festiniog Railway, seems the best for floor area of small wagons, viz.: twice the gauge by four times the gauge inside.

Besides wagons, the writer has built a brake van and passenger carriages; the former being fitted with a powerful and instantaneous foot brake. One of the carriages is open, and holds eight persons; the other is closed, and holds sixteen, twelve inside and four outside over the bogies. The seats are all transverse, seating two abreast. The wheels are mostly 13¾ in. in diameter, one wheel on each axle being loose, the other forced on by hydraulic pressure of from five to seven tons. The axles are all 1¾ in. diameter in the bearings and wheel bosses, and 2 in. where not turned. All wheels fitted during the last two years are chilled iron, cast at the writer's foundry. Most of the axles are lubricated from below by a sponge in a small oil vessel; the axle-box is of peculiar design, and fitted with an india-rubber spring. The hornblocks, axle-boxes, and oil covers fit together as they come from the foundry, and are held together by a bolt, after the insertion of which no part can get loose. These boxes cost 5s. each, of which 1s. is for the rubber spring, and 6d. for the bolt. They only require lubricating every month or so.

The buffers and couplings are central, a single cast iron buffer, having a coupler of the same metal hinged to it, being bolted to each end of the wagon by two thread bolts, which also hold the frame—of wood—together. These buffers are extremely simple, consisting only of two castings and a pin. They are self-coupling or not, as desired, and when set not to couple, the driver can, by a smart tap, bring the coupler down into the coupling position. The wagons can be fly-shunted either when the engine is drawing or pushing, the couplers sliding out laterally as the wagons diverge on different lines.

The writer has also at work a wrought iron self-coupling buffer, designed for a narrow gauge line of the Birmingham Corporation, where it is fitted to all the rolling stock. In this case, however, the wagons cannot be fly shunted without uncoupling. In the bogie stock the buffers are fitted to the bogies. The writer's principal aim has been to make the wagons as cheap and simple as possible, the cost being about 25s. per cwt. Iron wagons, no doubt, offer advantages in certain cases; but weight for weight they are scarcely so strong as those of wood; a light iron or steel body, however, wears well. Tipping wagons are of doubtful advantage on small lines, if the material has to be moved far, as they do not hold more than half the load of a good box wagon.

NOTES ON LIGHT RAILWAYS GENERALLY.

The writer proposes in the following remarks to deal with the application in this country of light locomotive worked railways of 2 ft. gauge or under, to do work at present done by horses and carts. The cases in which such lines can be applied may be defined as, firstly, isolated lines; secondly, branches from the railway system to works, quarries, farms, or public institutions, where a line of standard gauge would be objected to on the score of expense or unsightliness. Of the latter class it is probable that a vast number might be constructed which would well repay the outlay. The chief condition of success is a sufficient traffic between two definite points, and for this reason isolated lines will rarely answer, as the traffic is generally too varied in direction, except under special circumstances. It is said, however, that they have been made abroad on several large farms with advantage, even where unconnected with the railway system; but the writer himself cannot see how a locomotive line can be profitable for clearing land, or such purposes, where a considerable length of rail must be required, and that continually changing in direction. Light hand trams might answer in this way, but a locomotive essentially requires a good and cleanly-kept road if it is to work to advantage, and where there are bits of line laid down in this direction and that, which are little used, repairs are sure to be neglected. It is, therefore, in cases where a large traffic requires to be delivered on to the railway system, that such locomotive worked lines will be of most service. The small wagons should run right up to where the material requires to be loaded, so as to entail only one transshipment.

The line can be carried unfenced over the fields, avoiding arable land as much as possible, and crossing the hedges on two balks of timber, so arranged with a dike below as to prevent the passage of cattle. Even where the land is not owned, an agreement can usually be come to by paying a rent of 3d. to 6d. per yard run. The transshipment on to the railway should be effected by a raised platform, which will bring the floors of the small and large wagons to the same level, or, where the material is mineral, shoots can be erected. Every variety of such apparatus can be seen at work on the Festiniog Railway.

The gradients of these small lines should not, if possible, be greater than 1 in 40, as difficulty will be experienced in slippery weather, both in hauling anything like a load, and also in braking it down the inclines. The diminution of power on gradients may be thus clearly exemplified: If a locomotive will haul, as it should do, ten times its own weight on the level, it will haul only four times its weight up 1 in 50, twice its weight up 1 in 20, and once its weight up 1 in 12. The weight of the locomotive itself is, of course, not included in the loads hauled. More can be done on an emergency if the adhesion does not fail, but the above give a fair working average. It will thus be seen how important it is to keep the line as level as practicable.

The permanent way should be made a thoroughly sound job, as it will then cost but little for repairs. The rails should be fish-jointed, and fully strong enough for the load; say 18 lb. rails for an engine having one ton on each axle, and 26 lb. rails for two tons per axle. The sleepers may be then spaced 2 ft. to 2½ ft. apart; they should be fully double the gauge in length, or a little more, and amply deep enough not to bend under the load; about one-sixth of the gauge will be

right. As to width, 7½ in. will do for the 18 lb., and 9 in. for the 26 lb. rails; no sleepers should be used less than 6 in. wide, as the packing soon gets squeezed out. Narrower iron and steel sleepers are in use, and do well where bedded on a road or other unyielding surface; they are preferable to wooden sleepers when the line has to be laid in such places, as the surface requires to be disturbed to a much less depth. Dog-spikes are sufficient fastening for the rails; they should be long enough to go just through the sleeper, and each sleeper should have four; "ins" and "outs" on alternate sleepers do not answer.

Locomotives are infinitely preferable to horses for working these lines; horses knock themselves and the road to pieces, and are very unhandy in shunting, let alone the chances of their getting lamed. A small four-wheel coupled engine is undoubtedly the cheapest and best in all but exceptional cases; but whatever class of engine is employed, all the wheels should most certainly be coupled. Adhesion is a great point, as dirt, grass, or leaves all greatly reduce the gripe, and one of the chief difficulties is keeping the rails clean and dry.

Having mentioned the basis on which an effective narrow gauge line should be constructed, it remains to show what traffic is required in order that such a line may pay, and this can best be done by giving the relative cost of horse and cart traction on roads, and locomotive traction on rails. Loading and unloading will not be included, being the same in each case. Taking the distance apart of the two points between which haulage is required as one mile, and the smallest and cheapest gauge as 15 in., the cost of the line and rolling stock will be as follows: one mile of 15 in. gauge at 10s. per yard run, including the average earthwork required for a surface line, but no fencing:

Say 2,000 yards (which allows for points and sidings)..	£1,000
One 4¼ in. cylinder locomotive, 2 tons................	250
12 wagons to hold 1 cube yard, at £8 say............	100
Extras, say	150
Total cost of one mile of line complete..........	£1,500

The above engine would be capable of hauling a gross load, exclusive of its own weight, of eight tons up 1 in 50, which latter may be taken as a fair ruling gradient for a surface line. A gross load of eight tons would be equal to a paying load of about six tons, so that, supposing the engine to make one trip every hour, 60 tons would be moved in the day; although, with a double set of wagons, 100 tons could easily be managed. If the engine worked one day a week, or, say, fifty days in the year, it would have hauled 3,000 tons one mile (goods hauled on return journeys need not be taken into account), and the cost would be as follows:

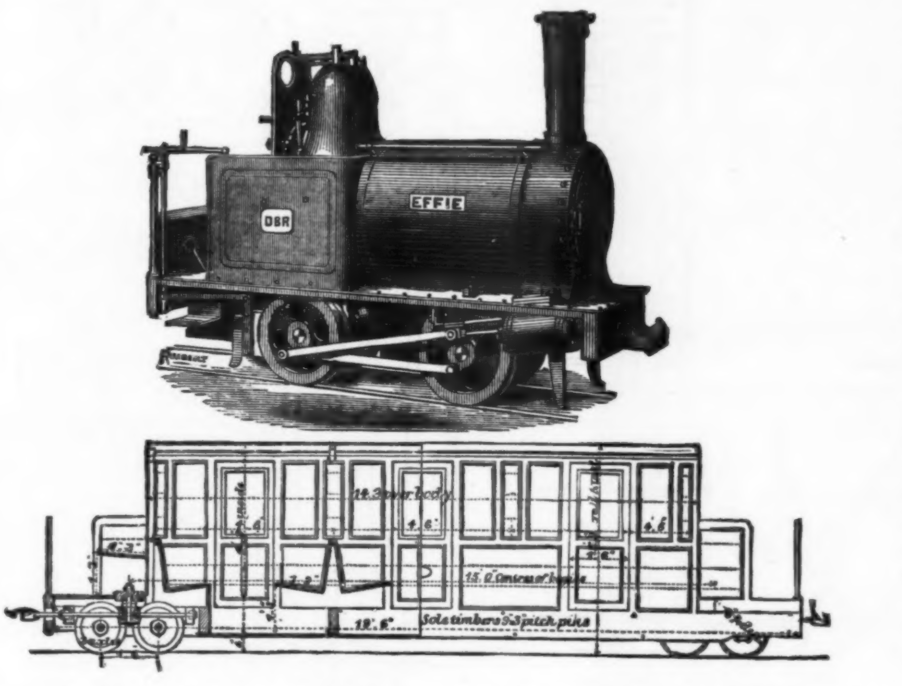
Interest on £1,500, at 5 per cent.............	£76
Driver and boy, 50 days, at 6s	15
Fuel, oil, and current repairs at 5s., say......	13
Renewal of line and rolling stock, at 20 years' life on £900	22
Cost of moving 3,000 tons one mile	£125
Equal to 10d. per ton.	

Now, the same haulage by horses and carts would cost in this country about 1s. per ton, and in this case there is the advantage, especially in agricultural districts, of the horses and cart during harvest time, or for hauling in other directions, which would more than balance the 2d. per ton saved by the railway. It is, therefore, probable that the latter would not pay unless the engine were required to work two days in the week, hauling, say, a minimum of 5,000 tons (or a proportionate number of cubic feet of light stuff) per annum. Beyond this amount the railway would pay well, as the outlay remains the same, and the renewal need not be put below twelve years. Working daily such a line will move material at 5d. per ton per mile; the longer the line the cheaper will the haulage be per mile. It will be observed that in the above estimates no allowance is made for way leaves or purchase of land; should these be required, the cost of transport would be increased accordingly.

The writer, in drawing these comparisons, is far from wishing to discourage the construction of light railways, for which he believes there is a wide future even in this country, but it must be borne in mind that where machinery takes the place of manual or horse labor, it is in all cases with one or two objects: either to do a larger amount of work than is possible without it, or to do it in a shorter time. Apply the same reasoning to locomotive-worked railways, and it will easily be seen whether they will pay as against horses and carts. The writer has known several ill-considered schemes of this kind which have ended in the whole plant being left to rust away, at considerable loss of capital to the owner, and of credit to the cause of light railways generally.

While, therefore, strongly advocating such lines, he would equally strongly urge that the question of expediency be first considered, and lastly, that if made at all, the whole should be as carefully surveyed, laid out, and constructed as a full-sized railway. The question of light railways in foreign countries has never had much of the writer's attention, except in the matter of army transport, in experimenting on which much of his time has been spent. The use of small lines in sugar plantations and other industries abroad is increasing extraordinarily, and cannot be too highly encouraged.

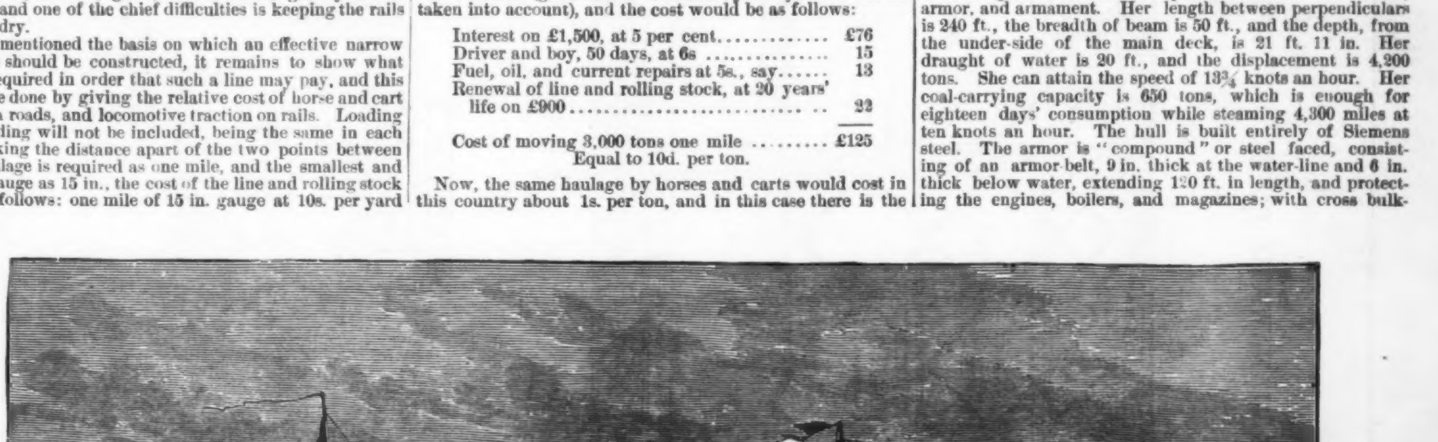
It is often not a question of whether steam is the cheapest means of transport, but whether there is any alternative, and the conditions for success depend so much on local considerations, that it is impossible to offer advice without entering into each individual case under the guidance of those on the spot. The whole subject of light railways is still in its infancy. It is only just beginning to be understood that these cannot be diminutive copies of full-sized lines; the conditions are entirely different, and we have yet to see the miniature railway developed. Year by year, the clumsy old portable engines have changed, till we now have as near perfection, both in simplicity of construction and in economy of working, as it seems possible to attain. So the light railway remains to be developed into a simple, easily laid, and enduring roadway, with cheap but effective locomotives, and wagons of every class carefully designed to carry their loads with the greatest convenience and minimum of dead weight.—*The Engineer.*



PASSENGER CAR AND LOCOMOTIVE.—MR. HAYWOOD'S 15 IN. RAILWAY.

THE ALMIRANTE BROWN.

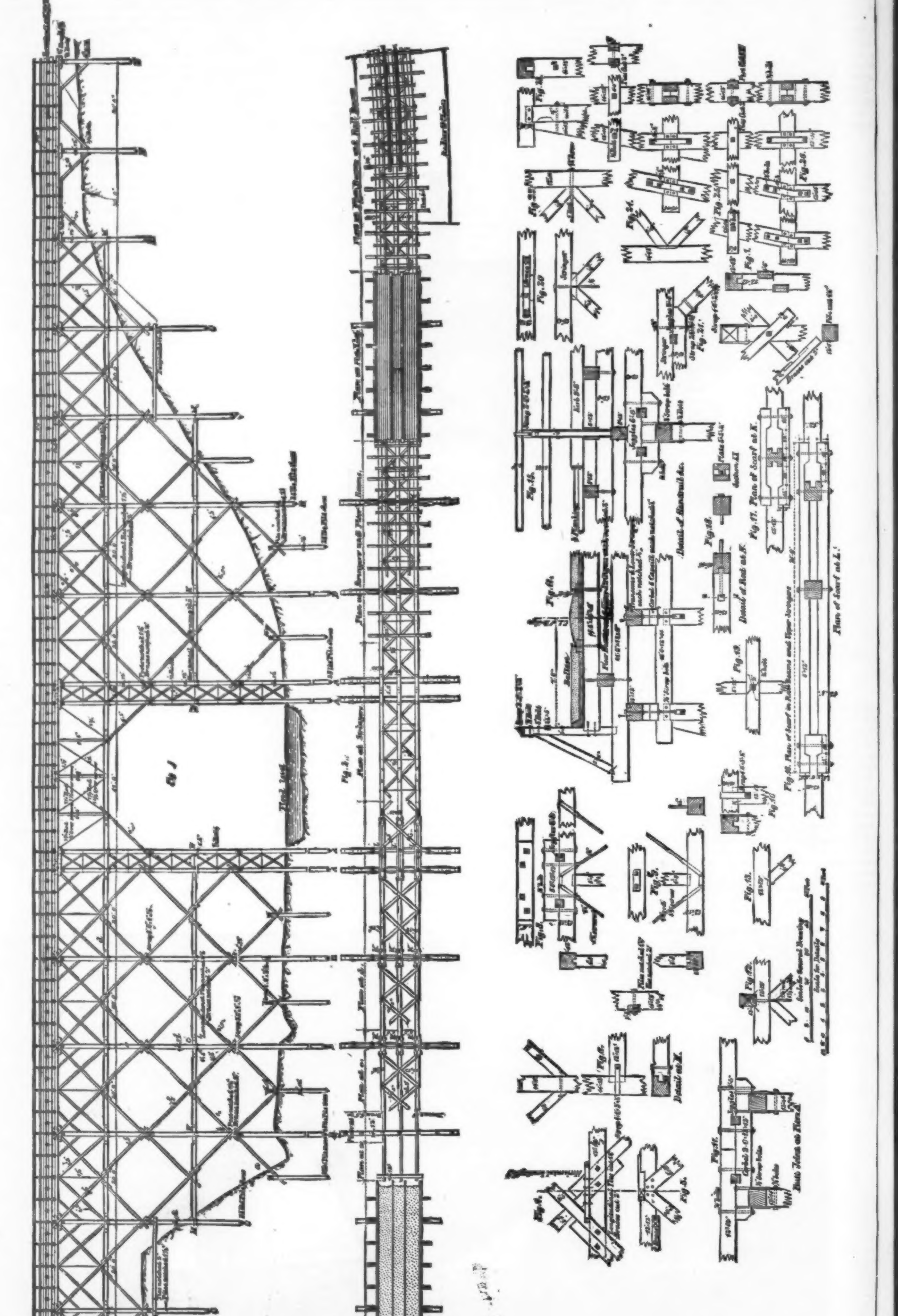
THIS vessel, named after Admiral Brown, distinguished in South American naval history, is a twin-screw armor-clad corvette, built by Messrs. Samuda Brothers for the Argentine Republic. She was launched in the Thames in October last year. The Almirante Brown is a vessel of moderate size, combining all the latest improvements in construction, armor, and armament. Her length between perpendiculars is 240 ft., the breadth of beam is 50 ft., and the depth, from the under-side of the main deck, is 21 ft. 11 in. Her draught of water is 20 ft., and the displacement is 4,200 tons. She can attain the speed of 13¾ knots an hour. Her coal-carrying capacity is 650 tons, which is enough for eighteen days' consumption while steaming 4,300 miles at ten knots an hour. The hull is built entirely of Siemens steel. The armor is "compound" or steel faced, consisting of an armor-belt, 9 in. thick at the water-line and 6 in. thick below water, extending 120 ft. in length, and protecting the engines, boilers, and magazines; with cross bulk-



THE ALMIRANTE BROWN, DOUBLE-SCREW RAM, FOR THE ARGENTINE GOVERNMENT.

BRIDGE OVER THE MANAWATU RIVER, ON THE NAPIER-MANAWATU RAILWAY, NEW ZEALAND.

MR. JOHN CARRUTHERS, ENGINEER.



heads, armored at the ends of the belt, and reaching from 4 ft. below the water-line to the main deck. Above the main deck amidships is an armor-plated battery, with double embrasures at the fore end, and containing in all six guns. The thickness of the armor on the battery sides is 8 in. and 6 in. At the ends it is 7 in. and 6. in. The armor-plates on the belt and on the battery are worked on a teak backing, averaging 10 in. thick. These armor-plates are screwed to the vessel with bolts and nuts, screwed from the inside, and so arranged as not to wound the steel face of the armor. The horizontal armor of steel plates 1½ in. thick, is worked from the battery to the ends of the vessel, forming a shell-proof and water-tight deck, four feet below the water, protecting the steering apparatus. The bottom of the vessel is covered with teak planking 3 in. thick, and with zinc sheathing as a protection against damage by fouling. The vessel is fitted with a double bottom, and is divided by transverse bulkheads and steel decks into numerous water-tight compartments. She is rigged with two pole masts, giving an area of sail of 10,000 square feet. Her engines consist of two sets of inverted compound surface condensing engines, of the collective indicated power of 4,500 horses; each set working its own screw, and being fitted in its own separate engine-room. The boilers are eight in number, and are cylindrical; the boiler-room is divided into four separate water-tight compartments. The armament consists of six Armstrong long breechloading guns of the improved type, of 8 in. caliber, each weighing 11½ tons. They are fitted in the battery, and so arranged as to give an all-round fire. There is one similar gun on the upper deck forward and one aft; also six 4½ in. broadside guns on the upper deck.—*Illustrated London News.*

BRIDGES ON THE NAPIER AND MANAWATU RAILWAY.

MR. J. P. MAXWELL lately read a paper before the Institution of Civil Engineers upon New Zealand Government Railways. We reproduce an engraving of the principal works on one of the lines, a bridge crossing the Manawatu ravine on the Napier and Manawatu Railway. The line first described by Mr. Maxwell in his paper was that from Wellington to Woodville, one of the first of a system of public works undertaken by the New Zealand Government in 1870. The leading characteristics of this railway, as projected, were a narrow gauge, 3 feet 6 inches, steep gradients, sharp curves, and low cost, not to exceed £5,000 a mile. Wellington, on Port Nicholson, lies between two mountain spurs of considerable elevation, which cut off the coast from the fertile country inland, and the selection of a route to cross this hilly country was a work of considerable difficulty. After several trial surveys, the line as finally laid out ran along the sea shore, and up a valley with a moderate gradient as far as the nineteenth mile, where it had attained an elevation of 202 feet. Then the mountain section began with a rise of 1 in 35 for three miles, after which, sometimes skirting the sides of the mountain, sometimes passing through gorges worn by watercourses, it reaches the summit level 1,141 feet above the sea at the thirty-fourth mile. From two and one half miles beyond this point to the present terminus of Featherstone, forty-five miles from Wellington, the ground is easy and gave little difficulty. This short distance of two and one-half miles, however, involved the adoption of gradients of 1 in 15, and the use of a central rail and Fell engines for working the traffic. The actual cost of the work entirely falsified the first estimates. Over the whole distance the expense of construction and equipment was £11,400 a mile, while the section of 1 in 15 cost over £28,000 per mile. The Napier-Manawatu railway is a line designed ultimately to connect with the railway running to Wellington, and passes through a much easier country than the one alluded to above. From Napier, a port on the east coast, the railway runs southward for sixty-four miles, through pastoral country; nine miles further it reaches the summit level 1,060 feet above the sea, but the gradients nowhere exceed 1 in 49. The last nine miles, however, run through a somewhat difficult and broken country, and on one section three ravines are crossed by timber viaducts of considerable dimensions. All these viaducts are of similar design, the one selected for illustration being that which crosses the Manawatu ravine, the others spanning the Mangarangiora and the Makatoka channel. The illustration shows in full detail the design and construction of these viaducts, which, except the fastenings, are entirely of timber, most of it obtained from the vicinity. The following gives some particulars of these bridges:

Viaduct.	Greatest Height.	Length.	Area in 100 sq. ft.	Total Cost.	Cost per 100 sq. ft.	Cost per lin. ft.
	ft.	ft.		£	£	£
Manawatu	89	484	207	5799	21·71	11·98
Mangarangiora.....	86	606	356	8412	23·63	13·86
Makatoka...........	76	224	106	3049	28·75	13·60

The timbers employed were totara, matai, black maire, and some Australian ironbark. Totara is especially suitable for trestlework. It is easily worked, is very durable, and grows to a considerable size, the trees ranging up to ten feet in diameter and seventy feet high. Matai is stronger than totara, but less durable. Black maire, a hard, very dense wood, is useful for scarfing and has considerable strength. The lower chords of the large opening on each viaduct were specified to be of this timber, but from the difficulty of getting long pieces, ironbark was substituted. The following table gives some particulars of the strength of the several classes of wood:

Timber.	Specific Gravity.	Weight per Cubic Foot.	Breaking weight of a Beam 12 in. long and 1 in. square supported at both ends and loaded in the middle.
		lb.	lb.
Totara (Podocarpus totara)	0·559	35·17	534
Matai (Podocarpus spicata)	0·658	40·74	760
Maire (Olea apetaca) ..	1·159	72·29	1,256
Australian ironbark...	1 138	70·92	1,128

The quantities of materials employed in the three viaducts and the prices paid were as follows:

		s. d.	£ s. d.
Timber....	536,518 ft. B.M.	32 0	8,584 0 8
Piling....	21,105 lin. ft.	4 8	4,924 12 0
Wrought iron.....	84,900 lb.	0 5	1,768 15 0
Ballast	352 cub. yds.	50 0	880 0 0
Excavation........	2,800 cub. yds.	2 6	350 0 0
			16,507 7 8
Engineers' expense.....................			502 0 0
Total			17,009 7 8

The viaducts were constructed for a single line of three feet six inch gauge, and are calculated for a moving load of one ton per lineal foot. The time occupied in their completion was two years.—*Engineering.*

RIVETING.

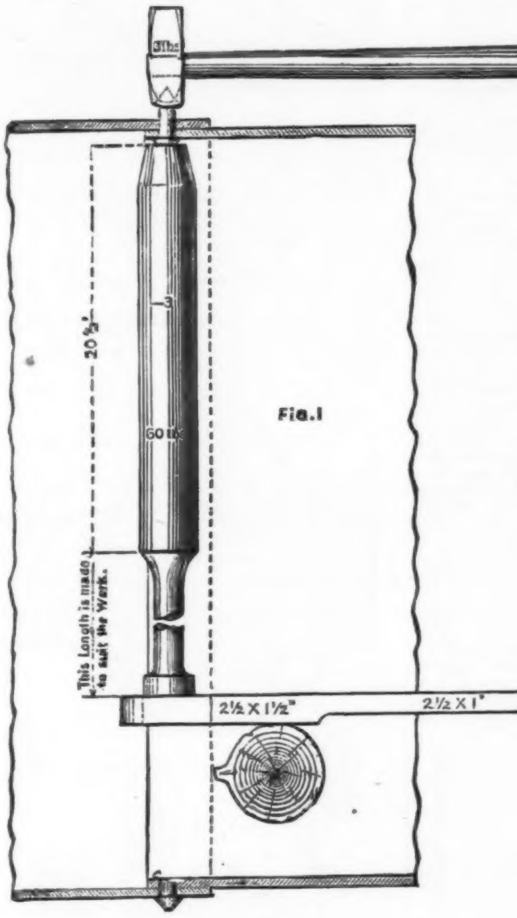
THE following report was presented to the Master Mechanics' Association at its recent convention in Providence:

Your Committee on Boiler Construction and Improvement, appointed at your last annual convention, after an interchange of opinion on the subject, concluded that each member of the committee should make an independent report to the convention on some branch of the subject assigned us for investigation, if circumstances should permit it, and that we would not undertake to make up a report embracing in one all that might be offered on the subject, but leave each member of the committee free to select his own subject for investigation, collect his facts, and make his report to the convention. So far as the chairman of your committee was concerned, no other course was practicable. The demands of business were such that time could not be spared to collect the data for a full report, and no other member of the committee seemed willing to assume the task, not having the time at command necessary to do the work.

A branch of the subject of boiler construction worthy of some further investigation, it seems to me, is that of "set riveting," commonly called button-set riveting in distinguishing it from hand riveting, as generally practiced in riveting boilers.

The idea usually conveyed by the term button-set riveting is the plan of forming the head of the rivet to the shape of a half globe, by placing on the end of the heated rivet a set with a rounded cavity, and driving it down with a sledge, at the same time slightly moving the set from side to side to round down the lower edge of the head to properly finish it. This plan has generally been regarded with disfavor, and has heretofore been but little used in riveting the seams of boilers where tight work was required.

A plan similar to this has been practiced for several years by the Louisville & Nashville, and perhaps other roads, in the construction of locomotive boilers, which at least, so far as the Louisville & Nashville road is concerned, has been so eminently satisfactory in all respects that a detailed description of the plan, and the tools used, will perhaps be considered worthy of your consideration.



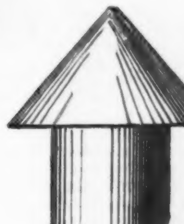


FIG.2.

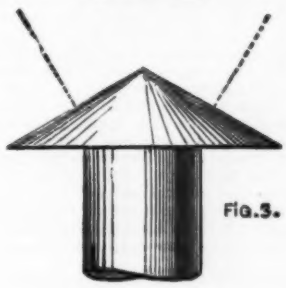


FIG.3.

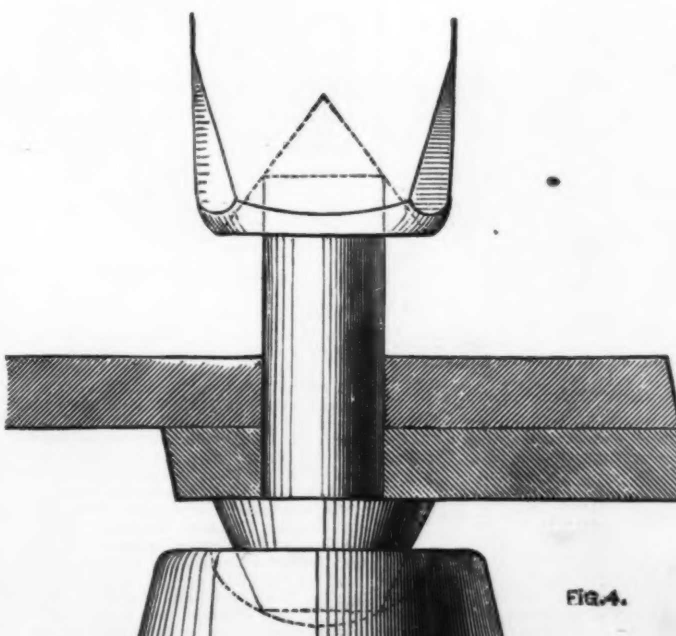


FIG.4.

RIVETING.

The object to be accomplished in riveting is to cause the rivet to perfectly fill the hole, and at the same time draw the plates perfectly tight together. The steam riveting machine undoubtedly best fulfills these conditions in its work; but all riveting cannot be done by steam riveters. The steam riveting machines are expensive in their first cost, and it is only where a large amount of work is to be done that the advantages derived will justify the outlay in capital. Smaller, and what may be called portable steam-riveting machines have lately been brought to the notice of the public; but it is questionable whether for locomotive boiler work they will prove a success. As before stated, it is only in cases where a large amount of riveting is done that the advantages of the steam riveters will warrant their cost, and a very large proportion of boiler riveting must therefore be done by hand, or some plan requiring a comparatively small outlay for tools.

The plan of set riveting consists of nothing more nor less than placing a set on the end of the rivet, having a conical-shaped cavity, of the shape and size of the finished rivet-head, holding it square, and driving this down on to the rivet, forcing the rivet against the holder, and swelling it until the hole is perfectly filled, the head formed, and the plates drawn tightly together.

The manner of driving rivets by this plan is illustrated in Fig. 1, which shows the position of the set as held on the end of the rivet while being driven down by the sledge to form the head. The weight of the set is from two and a half to three pounds, and of the holder about sixty pounds, and of the sledges nine or ten pounds each.

The size of the conical cavity in the set for forming the head on a $\frac{3}{4}$-inch rivet is $1\frac{5}{16}$ inches diameter at the base and $\frac{3}{4}$ inch deep, which forms a head as represented in Fig. 2.

The length of the rivet should be so proportioned that when driven the lower edge of the set will about touch the sheet so as to leave no surplus iron at the base of the head; at the same time the body of the rivet filling the hole, and the head being perfectly formed and full size.

In driving rivets by this plan no skilled labor is required, other than knowing how to place the holder tightly on the rivet when put in the hole, and holding the set squarely on the end of the rivet, and sledging it down to form the head; the operation requiring two men to sledge, one to hold the set, one to manage the holder, and a boy to heat the rivets. The rivet is not struck direct by the sledges at any time during the operation of driving, but the head is formed entirely by driving the set down squarely on the end of it. To drive a rivet requires about twenty-four blows with the nine or ten pound sledges at the rate of about eighty blows per minute; a flatter with a face about one and a half inches square is then placed on the lap alongside the rivet, and given five or six blows to close the sheets together; the set is then placed on the rivet-head again, and given five or six more blows, and the rivet is finished, the whole operation of driving requiring about thirty-five seconds of time to the rivet.

In practice we find that a riveting gang will drive in the seams of the shell of a boiler an average of thirty rivets per hour, or three hundred per day, and in the seams of the fire-box, in throat and back sheets, dome, mud-ring, braces, etc., an average of about twenty-two rivets per hour. This includes the time necessary for taking out bolts, drifting holes, adjusting the tools, and the work.

In hand riveting we find that two riveters will drive, on an average, taking the whole boiler, only about one hundred and twenty-five rivets per day, or twelve and a half per hour.

At these rates of driving rivets by the two different methods, the difference in the cost of driving the rivets in one of the standard boilers of the Louisville & Nashville Railroad Company for an eighteen by twenty-four inch cylinder engine, and the time required to do the work, would be as follows: the boiler being double seamed in all transverse seams, and "welt seams" in all longitudinal seams; the number of rivets in the boiler being as follows:

Rivets in fire-box seams	284
" mud-ring—long rivets	94
" smoke-box—long rivets	32
" dome ring " "	38
" " flange	69
" " vertical seam	12
" front flue-sheet	62
" back seam of smoke-box	32
" connection, rib braces	40
" vertical braces in dome	18
" angle iron bracing	30
" " " " back head	28
" " " " front "	31
" long braces to barrel	36
	780
Rivets in shell, first transverse seam	128
" " second " "	128
" " third " "	152
" " throat sheet, corners	64
" " longitudinal seam, first	40
" " " " second	40
" " " " third, two	80
Rivets in shell longitudinal wagon top, two	112
" " back head	168
Total in shell	912
" fire-box, braces, etc	780
	1,692
Rivets in fire-door flanges	30
Total rivets in the boiler	1,722

To drive these rivets, leaving out the thirty rivets in fire-door flanges, which require special care and arrangements for driving, the cost by the set riveting plan, and the time required, would be as follows:

Four men at 15 cents per hour	60 cents
One boy at 8 cents per hour	8 cents
Cost per hour for labor	68 cents

The 780 rivets in the fire-box, mud-rings, dome, smoke-box, angle iron, etc., would be driven at the rate of twenty-two rivets per hour, requiring 35·45 hours time and cost \$24.10, or at the rate of 3·09 cents per rivet. The 912 rivets in the shell of the boiler would be driven at the rate of thirty rivets per hour, and require 30·4 hours time, and cost \$20.67; or an average of 2·26 cents per rivet, making the total cost for the boiler \$44.77, and time required to do the work 65·85 hours; the average cost per rivet would be 2·64 cents.

To drive the 1,692 rivets by hand, at an average rate of 125 rivets per day, or twelve and a half per hour, would require 135·36 hours time for a gang of riveters to do the work, costing as follows:

Two riveters at 25 cents per hour	50 cents
One helper to hold rivets	15 cents
One boy to heat rivets	8 cents
Cost per hour for labor	73 cents

This would make the cost of driving the rivets for the whole boiler amount to \$98.81, or an average of 5·84 cents per rivet, and require a little more than $13\frac{1}{2}$ days time to do the work, as against \$44.77, and a fraction more than $6\frac{1}{2}$ days time to perform the labor, by the set riveting plan, a difference in favor of the latter of 54 per cent. in cost and 51 per cent. in time.

In the case of hand riveting, where but little time is lost in moving the work and adjusting tools, taking out bolts, etc., as many as sixteen or eighteen rivets can be driven per hour; but taking the whole boiler, and the occasional delays in moving the work, the average will be about as stated above.

In like manner, in set riveting, nore than thirty rivets can be driven per hour without difficulty, when no unusual time is lost in adjusting tools and the work, but the average will be about as I have given it.

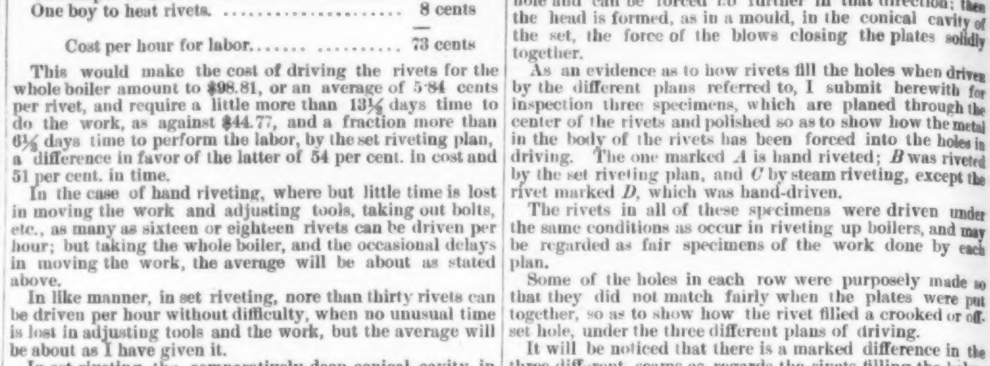
In set riveting, the comparatively deep conical cavity in the set prevents the end of the rivet from swelling out or spreading, as it otherwise would if driven with the face of a hammer, and in consequence it is driven well down into the hole until it is perfectly filled, or as nearly so as it is possible to cause a rivet to do that is hotter when driven than the metal in the plates. Driving with set and sledges, the rivet need not be quite so hot as in the case of hand driving, and consequently it will fill the hole more perfectly when cold; also in driving the rivet, the force of the blows given is in exactly the proper direction to accomplish the object of forcing the rivet down and swelling it, until the hole is perfectly filled, and plates closed together; while in the case of hand riveting, after striking the rivet a few blows squarely on the end with the riveting hammers, the direction or force of the blow is changed to an angle from the centre line of the rivet, and instead of being in the direction to drive the metal solidly into the hole, it is slightly in the direction to drive the rivet from one side to the other in the hole as indicated by the dotted lines in Fig. 3. This is more particularly the case when the rivet heads are sharply pointed. In driving rivets by hand, the weight of the hammers is only about three or three and a half pounds, and it is with their comparatively light blows that the metal of the rivet is expected to be forced down into the hole so as to perfectly fill it. Whether this expectation is realized in a majority of cases or not may easily be determined by planing a seam through the center of the rivets. On the other hand, in driving rivets by the set riveting plan, sledges are used weighing from nine to ten pounds, and the blows are given as hard as men can strike, by swinging the sledge overhead, and are given squarely on the end of the rivet, the set preventing the projecting end from spreading until the rivet has filled the hole and can be forced no further in that direction; then the head is formed, as in a mould, in the conical cavity of the set, the force of the blows closing the plates solidly together.

As an evidence as to how rivets fill the holes when driven by the different plans referred to, I submit herewith for inspection three specimens, which are planed through the center of the rivets and polished so as to show how the metal in the body of the rivets has been forced into the holes in driving. The one marked *A* is hand riveted; *B* was riveted by the set riveting plan, and *C* by steam riveting, except the rivet marked *D*, which was hand-driven.

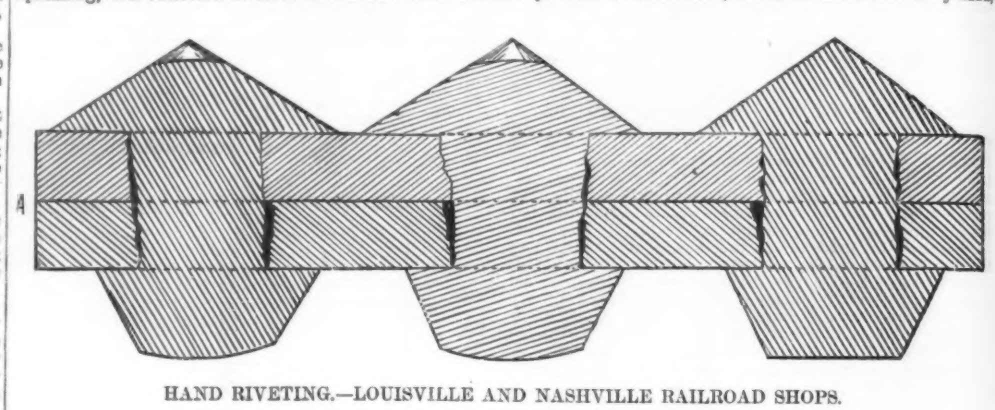
The rivets in all of these specimens were driven under the same conditions as occur in riveting up boilers, and may be regarded as fair specimens of the work done by each plan.

Some of the holes in each row were purposely made so that they did not match fairly when the plates were put together, so as to show how the rivet filled a crooked or off-set hole, under the three different plans of driving.

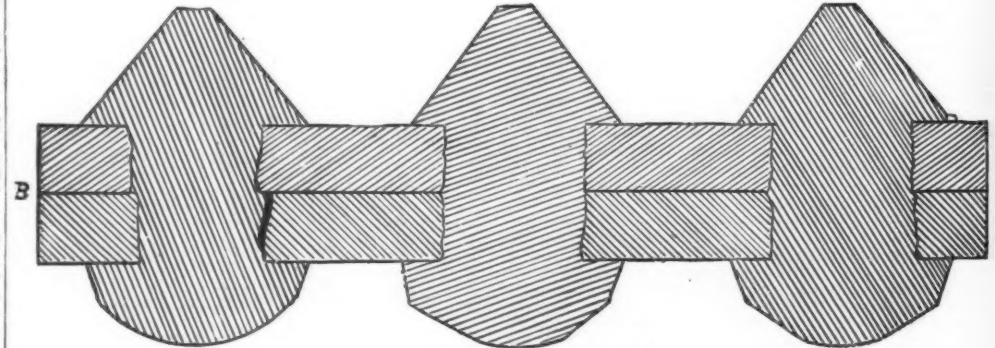
It will be noticed that there is a marked difference in the three different seams as regards the rivets filling the holes, those driven by the steam riveter filling as perfectly as it is possible to make them, but it is those driven by hand, and by the set riveting plan, that are more particularly under consideration in this report.



HAND RIVETING.—LOUISVILLE AND NASHVILLE RAILROAD SHOPS.



"SET" RIVETING.—LOUISVILLE AND NASHVILLE RAILROAD SHOPS.



STEAM RIVETING. HAND RIVETING.

The plates seem to be drawn together equally well in the three different specimens, but the rivets do not fill the holes nearly so well when driven by hand as those driven by the set riveting plan; in fact, very few of them fill the hole except immediately under the head. On the other hand, those driven by the set plan in most cases fill the holes perfectly, and they are a very much better job of riveting than those driven by hand; they are as much better than hand driven as steam driven are better than those driven by the set riveting plan.

Neither of the two samples is perhaps as good as it is possible to drive the rivets, but in the usual manner of doing such work they are fair average specimens of $\frac{3}{4}$-inch rivets driven in plates $\frac{7}{16}$ inch thick. The reason for such conclusion is based on the result of several different tests, the specimens being planed through the center of the rivets, the same as these, in order to see how the holes were filled by the body of the rivet in the case of each plan of driving them.

A number of steel boilers in use on the Louisville & Nashville lines have been made in which the rivets were driven by the set riveting plan, including those in the fire-box, throat-sheet, mud-ring, dome flanges, etc.; in fact, almost every rivet in the boiler, including the countersunk rivets, a

special shaped set being used, however, for the latter. These boilers are all perfectly tight, and were so from the first.

Unquestionably, rivets driven by the plan described fill the holes more perfectly than those driven by hand, and the plates are drawn together equally well; and from practical experience in the construction of a number of boilers, the cost of labor in driving the rivets is found to be only about one-half that of driving them by hand, and the time required to do the work is also reduced in the same proportion.

Now, if these are the facts, it is difficult to give a reason why hand riveting is so generally practiced where steam riveters are not used; and why set riveting has not heretofore been adopted to a much greater extent, if the plan is a better and cheaper one than the old plan of driving by hand. Set riveting is certainly nothing new under the sun. Experience, however, has demonstrated the fact that skilled labor looks with disfavor upon any plan of doing work whereby unskilled labor is able to accomplish the same thing equally well, at reduced rates of wages. There is a natural inclination to oppose new ways of doing a thing, especially when it involves, to a great extent at least, the abandonment of a practice followed almost universally in the construction of boilers, until partially superseded by steam riveting within the past fifteen years. Boiler making is carried on mainly by those skilled in the old way of doing work, and it is not natural that they should desire a different plan, more particularly when it dispenses with what is valuable to them—their skill in driving rivets—and as a class they oppose and discourage the plan of driving rivets by a plan such as a set and sledges. These are doubtless some of the reasons why set riveting has not met with greater favor. It seems to me, however, that this plan of set riveting, owing to its cheapness and expedition in doing the work, should receive more attention in the way of carefully made tests as to the quality of the work done by it, and the cost for labor, than has heretofore been given to it, and it is with the view of calling attention to the plan that this report has been written.

Steam riveters drive from 30 to 60 rivets per hour, depending on the machine, the character of work, and the way it is managed, and the cost for labor of the gang driving the rivets varies accordingly from 1·1 cts. to 3 cts. per rivet.

A gang of men driving rivets by the set-riveting plan will average about 26 rivets per hour, taking the whole boiler, at a cost for labor of 2·64 cents per rivet; and to drive them by hand a gang of men will average about 12½ rivets per hour, for the whole boiler, at a cost for labor of 5·84 cents per rivet.

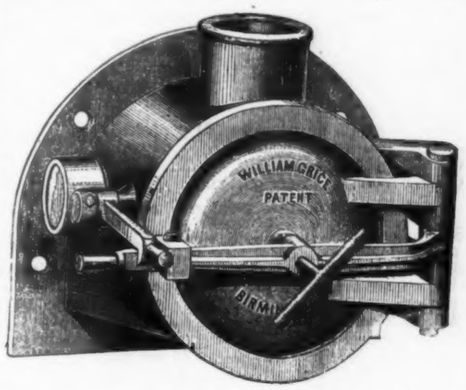
The figures given as to the work done by steam riveters and the cost for labor were furnished by two prominent locomotive-building firms as the work done by their machines. *All* the riveting in boilers, however, is not done on their steam riveters; a portion of it is done by hand; therefore, taking the whole boiler into account, the average cost per rivet will be considerably above that of the rivets driven by the machines.

The cost of set riveting as given is made up from the average day's work in driving rivets in new boilers built, and the cost of hand riveting is that given by those building boilers by that plan of driving rivets, so that the figures given above may be regarded as tolerably accurate in the cost of doing the work by the three different plans of riveting.

R. WELLS,
Chairman of Committee.

A NEW SELF-SEALING RETORT MOUTHPIECE LID.

THE retort mouthpiece and fittings shown in the annexed illustration are the inventions of Mr. W. Grice, and were first brought before the public at the Glasgow exhibition last autumn. Since then several alterations have been made in the apparatus, and it is from the latest form of the simple mouthpiece and lid that our figure is taken. The mouthpiece may, it is said, be made to suit any size and shape of retort. The lid is hinged on one side of the mouthpiece, the hinge being made very deep and strong, with a view to securing as steady a movement of the swinging lid as possible. The lid is provided on its inner face with a V-ridge, which fits in a corresponding groove on the face of the mouthpiece when the crossbar screw is tightened up. A metallic joint is secured by the contact of the sides of the V-ridge with the sides of the groove, thus giving what is



claimed as a double, instead of the single contact obtainable when the edge of the lid is applied either to the plane face of the mouthpiece or to the bottom of the groove. This apparently slight distinction is said to be of considerable importance in the ordinary course of working. The crossbar is, of course, hinged with the lid, and when brought into action for screwing up, it engages at the free end with a catch, which is balanced as shown. The balance weight causes the catch, or lug, to fly up out of the way when the crossbar is disengaged, so that one side of the mouthpiece is always free from projections of any kind while it is opened for drawing and charging. The arrangement is, we believe, now on trial in several large gasworks. Another form of Mr. Grice's invention includes the provision of a valve in the ascension-pipe.—*Journal of Gas Lighting.*

WEBER'S EXPLOSIVE GAS TELLTALE.

WE illustrate the explosive gas telltale, invented by Herr R. Weber, of Leipsic. The instrument is shown as fixed on the wall of an apartment, near the ceiling, in the best position to give instant warning of the escape of illuminating gas in the room. As previously described, the apparatus consists of a bracket-back, R, of any suitable material, to which is fitted the metallic drum, K, set on the vulcanite base, P. This drum is closed in front by the porous diaphragm, S. The small bent pipe, *r*, which establishes communication with the interior of the drum, is partly filled with quicksilver, and is prolonged at *b* into a glass tube, which carries on its upper end the metallic cap, *h*, through which passes a needle, capable of being raised and lowered by the screw, *s*. The wires, *d*, *d*, connect the outside of the instrument with the alarm; while the cap, *h*, and the needle carried by the same is connected with the alarm in the same way by the wire, *a*. When the air in the instrument is in its normal state, there is perfect equilibrium of pressure within and without the drum. The quicksilver in the tube, *r*, which is virtually a pressure gauge, is level in

both limbs, and at its normal distance from the needle above mentioned. When gas is permitted to escape from the burners, it at once passes by a well known law into the space behind the porous diaphragm, and consequently raises the pressure, which causes the mercury to rise, and as soon as the quicksilver reaches the needle the electric current is completed, and the alarm is set in action.

CURATOR'S LODGE, BOTANIC GARDENS, CAMBRIDGE.

THE house which we illustrate was built by the Botanic Garden Syndicate, at Cambridge, from the design of Mr. W. M. Fawcett, M.A. It is a small house with two sitting-rooms, kitchen, etc., four bedrooms, and small bath-room; there is also an office for the curator and the syndicate. It is built of red brick and has bay windows. The barges and cornices are all of wood. The lodge stands near the side entrance from Panton street, and this is most used for the general management of the gardens. The principal aspect is south, and the windows have a good view of a large portion of the gardens.—*Building News.*

SUGGESTIONS IN ARCHITECTURE.—CURATOR'S LODGE.

CUBA, HER RELATIONS WITH THE UNITED STATES.*

UNTIL within a few years the requirements of the people in Cuba were generally met by the importation of goods of English make. Spain supplied some articles, and France gave her perfumery and *objets de vertu*. American goods were nowhere to be found; both wholesale and retail dealers were in profound ignorance of the fact that almost at their doors they had a producer of everything which the extended and raised wants of civilized life made necessary. The English and Germans here took good care to decry all American manufactures, and as the Spaniard is above all else a creature of custom and habit, preferring to follow in the course established by his ancestors, they found it no difficult task to continue the monopoly that existed. Circumstances seemed also to favor them. The inflation of prices in the United States, produced by the war, made it impossible to compete with the English in offering goods of any kind. The establishment of lines of Spanish steamers between Havana and Liverpool permitted the importation of merchandise at low rates of freight and at lower duties than could be done with American articles. The higher price of cost and the greater expenses attending the importation operated as an effective bar to American trade in the way of imports. The consequence was that our exports to Cuba rarely passed $15,000,000 per year, while our imports frequently exceeded $80,000,000; and the anomaly was presented of merchants going across the Atlantic, over 3,000 miles away, to get stock which they could readily obtain in New York, only one-third of the distance. These causes still operate to lessen trade, and Europe still supplies Cuba with the bulk of her imports. There seems, however, to be more effort and willingness to draw from the United States, and it is not uncommon now to find American shoes and calicoes, and even Yankee notions. Certain articles of food have always been imported from the United States, such as lard, beans, bacon, hams, etc.; of these the United States are the exclusive exporters. Some flour and butter are also brought; live stock for consumption and breeding; machinery, locomotives, lumber, a few agricultural implements, all kinds of cooperage, and a little coal. The smaller articles comprised in a hardwareman's stock are, however, almost exclusively brought from England, so also with the clothing and dry-goods' stores. Some American calicoes (or percales), occasionally cotton shirting, etc., are found, but they are not common. The retail dealers admit the good quality of American prints, but frankly say that they cannot bring them here as long as the cost is greater than those of England. The causes of this have already been indicated, and until they are removed it is useless to hope for an increase in the trade with the United States. It seems not impossible that within a comparatively short time changes of importance may occur. The Spanish Government is alive to the urgent necessity of doing something to alleviate the general distress here, and the proposed measures are numerous and varied. One proposal is, the abolition of what are called the differential flag duties, and at the same time a material reduction in the tariff duties.

DISCRIMINATING DUTIES.

The differential flag duties, as in force to day, are a very material and striking discrimination in favor of the Spanish flag. The removal of this, establishing a uniform duty, for the goods of all nations, in whatever bottoms they may be imported, will at once put an end to the European monopoly by placing American goods on the same basis as others. In order to complete and perfect the reform, the United States would then have to remove the discrimination now made against goods imported there in Spanish bottoms, and as there would be a constant stream of Spanish vessels to the United States, the low rates of freight, which they are in the habit of charging, would be enjoyed by the American exporter, as they are now by the Europeans.

The ultra Spanish element is opposed to the abolition of discriminating duties, on the ground that it would work the destruction of the Spanish merchant marine, and at this moment there is a fierce discussion going on in the public press. It is useless to point out the arguments *pro* or *con*, as the government will probably be but little influenced by the opinion here.

Recognizing, as they do, the critical financial condition of the island, and the absolute necessity of applying a remedy, they will be compelled, during the present session of the Cortes, to adopt some healing measures.

AMERICAN PRODUCTIONS MOST IN DEMAND IN CUBA.

Agricultural Implements.—Plows, cultivators, rakes, hoes, forks, coffee cleaners, machetes or cane knives, sausage-meat cutters, bagazo spreaders, sugar mills, portable railroads, sheep-shearers, corn-shellers, spades, and shovels.

Sugar Machines.—Mills, centrifugal apparatus, vacuum pans, stampers for hogsheads and boxed sugars, fire-brick.

Glassware.—Lamps for petroleum, goblets, tumblers, lightning-rod insulators, glass tubes, vases, and window panes.

Domestic Utensils.—All sorts of hardware, such as pots, pans, cups, stoves, coffee and tea pots, sieves, mortars and pestles, etc.; crockery, tubes, buckets, dippers, coffee and pepper mills.

Cutlery.—Knives, forks, spoons, carving knives, and potato knives.

Hardware.—All sorts of carpenters' and builders' tools, planing-machines, moulding machines, machinery for making windows and shutters, hand drills or foot-power drills, turning and mortising machines, band saws, hand saws, chisels, scroll saws of the large kind, carving instruments, etc.; paints, especially fire-proof paints, putty, lubricating and paint oils.

Clothing.—Shirting, calicoes, lighter classes of woolen goods; shoes if made according to the Cuban pattern—sharp-points, high instep, and narrow; buttons, thread, linings, etc.

Soaps.—The cheaper sorts and small importations of fine.

Stationery of all sorts.

Locomotives, and all sorts of railroad supplies

Sewing-machines, hand and treadle.

RETAIL AND WHOLESALE PRICES OF PROVISIONS AND DRY GOODS IN CUBA.

RETAIL PRICES OF PROVISIONS IN CUBA.

Flour: wheat, superfine, $38 to $40 per barrel; extra family, $35 per barrel.

Beef: fresh roasting pieces, 60 to 75 cents per pound; soup pieces, 55 cents per pound.

Veal: forequarters and hindquarters, 75 cents per pound; cutlets, $1 per pound.

Mutton: forequarters and leg, 55 cents per pound; chops, 60 cents per pound.

Pork: fresh, 55 cents per pound; corned or salted, 40 cents; bacon and ham, 65 cents per pound.

Lard: 38 and 40 cents per pound.

Codfish: dry, 20 cents per pound.

Salt fish: mackerel, hake, and haddock, 20 cents per pound.

Butter: $1 to $1.50 per pound, according to quality.

Cheese: $1 to $1.25 per pound.

Rice: 20 cents per pound.

Potatoes: $10 to $12 per barrel, paper.

Beans: 15 cents per quart.

Milk: 50 cents per gallon.

Eggs vary greatly, from 12 to 18 for $1.

RETAIL PRICES OF GROCERIES, ETC.

Tea: Oolong or other good black, $2.50 per pound.

Coffee: green, 45 cents; roasted, $1 per pound.

Sugar: brown, 10 cents; white, 20 and 24 cents per pound.

Molasses: 30 cents per quart.

Soap: common, 12 cents; fine, $1 per cake.

Starch: 16 cents per pound.

Coal oil: $1 per gallon.

Coal: $7 and $8.50 per ton, gold.

RETAIL PRICES OF DOMESTIC DRY GOODS.

Shirtings: bleached, 25 and 30 cents per yard; unbleached, 20 and 25 cents per yard.

Sheetings, as known in the United States, *i. e.*, double width, are not brought here; cotton sheets are made of the single width of bleached shirting.

Woolen flannel: $1.75 per yard, good quality.

Prints: 25 and 30 cents per yard.

Mousseline de laines: 75 cents to $1 per yard.

Shoes: men's and women's, $8 to $10 per pair.

HOUSE RENT.

House rent varies according to style and location. A small house of two or three rooms commands $25 per month in paper. A house of six or eight rooms, in a good locality, commands from $75 to $100, gold, per month.

DUTIES ON IMPORTS AND WHOLESALE QUOTATIONS.

(Besides the duties marked in this review, an addition of 25 per cent. is paid on all imported articles as war contribution. *All duties* are payable in Spanish gold.)

Apples: 2½ cents per kilo under the Spanish flag, and 3¼ cents per kilo under foreign flag; quoted at $5 and $6 per barrel, gold.

Beans: duty, $2.15 per 100 kilos, quoted at 22 and 22½ reales per arrobe, paper.

Brooms: duty, $8 per 100 kilos; quoted at $4½ to $8½ per dozen in paper, according to quality.

Butter: duty, $11.50 per 100 kilos; quoted at $63 to $68 per cwt., paper, according to class and packages.

Candles: duty, $13 per 100 kilos, composition and sperm; quoted at $28 and $29 per cwt., in paper.

Cheese: duty, $11.80 per 100 kilos on Dutch, and on American $8.26 per 100 kilos; flat and round, quoted at $56 and $58 per cwt. in paper.

Chewing tobacco: duty, $14 per 100 kilos; quoted at $51 and $55 per cwt., according to quality.

Clear pork: duty, $8.25 per 100 kilos; quoted at $30 to $30½ per cwt. for ribs, and $31 for shoulders.

Coal oil: duty, $1.40 per 100 kilos; quoted at 10 reales per arrobe, paper.

Crackers: duty, 4½ cents per kilogramme; common classes quoted from 14 to 20 reales for small tins.

Salt fish: duty, $3.80 per 100 kilos; quoted for cod, $14 per cwt. and $12 to $13 per cwt. for hake and haddock, paper.

Corn: duty, $1.40 per 100 kilos; quoted at 10 reales per arrobe.

Flour: duty, from Spain in Spanish vessels, $2.25; for Spanish in foreign vessels, $4.50: from foreign countries, in Spanish vessels, $4.62½; from foreign countries in foreign vessels, $5.51 per 100 kilos, including the weight of the barrel; quoted at $27½ to $28 per barrel, and at $26½ in bags; American, from $30½ to $31 per barrel, and from $28½ to $29½ in bags, according to brands, paper.

Hams: duty, $8.35 per 100 kilos for American,* and $19.30 for Westphalia, per 100 kilos; quoted at $30 and $40 for middling and good classes.

Hay: duty, $1 per 100 kilos; quoted from $9.50 to $10 per American bale, paper.

Smoked herrings: duty, $2.45 per 100 kilos; quoted at 7½ and 8 reales per box, paper.

Lard: duty, $9.75 per 100 kilos; quoted at $34½ to $34¾ per cwt. in tierces; whole tins at $38 and $38½ per cwt.; halves and quarters at $39½ and $40 per cwt., paper.

Oats and bran: duty, per Spanish flag, 11 to 20 cents per 100 kilos, and per foreign, $1.40 per 100 kilos; oats quoted at $6½ per bag; bran, at $5½ per bag, paper.

Onions: duty, $1.40 per 100 kilos; quoted at $6½ per cwt., paper.

Oysters: duty, $24 per 100 kilos; quoted at $11½ and $12 per box, paper.

Paper: duty, $3.80 per 100 kilos; quoted, American straw yellow paper at 8¾ to 8⅞ reales per ream; Belgian, from 8 to 8¼ reales per ream; Manila, 10 to 10¼ reales per ream, paper.

Pickles: 16⅛ cents per kilo; quoted from $5 to $13 per box, according to quality and size of bottles, paper.

Potatoes: duty, $1.40 per 100 kilos; quoted from $9 to $9.50 per barrel, paper.

Salt: duty, $2.37 per 100 kilos for fine, and $1.18 for coarse; quoted from $7.50 to $7.75 per 200 pounds.

Coals: duty, 60 cents per 1,000 kilos; quoted from $6½ to $7 per ton, gold.

Lumber: duty, $6.40 per 1,000 superficial feet; quoted at $30 per M., gold, for white pine boards, and $30 to $30½ per M., gold, for pitch pine lumber.

LABOR IN CUBA.†

There are in Cuba three classes of laborers, the negroes, Chinese, and whites. The first two are dedicated almost entirely to agriculture, and the latter to town industries. Owing to the operations of the Moret law, and to voluntary manumissions, the number of slaves has diminished greatly in recent years. The freed negroes usually remain in the country, and generally on the estates of their late masters. The Chinese now here were imported as laborers by several large companies, not now existing, under what was known as the contract system. They were bound before leaving China to work for eight years at $4.25 gold per month, and a condition was that at the expiration of that time they were to be returned to their native country.

The government of the island of Cuba, however, in view of the scarcity of labor, determined that the Chinese should recontract or leave the country *at their own expense*, and as very few, after completing their eight years of servitude, were in condition to do this, the result was that they were forced into from four to six years of additional bondage. The treatment of the Chinese was so tyrannical that the Government of China was finally forced to prohibit exportations of laborers to Cuba, so that some years have passed since there has been any immigration whatever. The consequence is that nearly all the contracts now existing are on the point of expiring, and the freed coolies are being hired by planters at current prices.

The price paid for labor to negroes and Chinese varies to some extent, according to the locality. For the latter, from $12 to $15 per month, and for the former, from $15 to $20 per month. The maintenance of the laborers is at the charge of planters, and may be estimated at from 30 cents to 40 cents per day in gold. Their food consists of rice, jerked beef, sweet potatoes, corn, and plantains, with occasional rations on some estates of salt fish. The negro prefers corn meal, but to the Chinaman rice is indispensable. On nearly all estates the negroes are permitted also to have a pig, a few chickens, and a small patch of ground for planting. They never plant, however, anything but staple articles, such as corn and plantains. Garden vegetables are unknown to them, so that their life is a monotonous round of ill-requited labor and simple though substantial fare. Two suits of clothing during the year are deemed sufficient to cover their wants, and possibly they may be, for when at labor in the fields they are almost in nature's garb.

The quarters of the negroes and Chinese in Cuba is usually a large stone house, forming a long parallelogram, with one entrance. The interior is divided into two divisions, and the rooms are situated on the four sides of a large yard. The rooms open into this yard, and rarely have windows. One division is for the males, and one for the females; but as there is free communication between them there is practically no separation of the sexes. The rooms adjoining the entrance are usually large and well-lighted, with a balcony or porch in front. These are occupied by the "mayoral" or driver, who is the controller and immediate governor of the laborers; said driver assigns their tasks, administers correction, etc., under instructions from the administrator. One day in the week is given for rest and recreation, but not necessarily on Sunday. The owners of adjoining estates manage among themselves so that laborers of two plantations never are idle on the same day. They object to free intermingling, in order to prevent the intrigues, combinations, etc., which at one time frequently culminated in insurrections.

The recreations of the negroes are few and simple. They dance, sleep, and sun themselves; beyond this they have no amusement. They are called to labor at five o'clock in the morning, and have two intermissions during the day for meals, and at six o'clock in the evening they are back in the barracks locked up for the night—a life of unceasing toil, unalleviated by any domestic joys, without contact with the outer world; no interest, ties, or thoughts beyond the confines of the plantation, they plod on from childhood to death, and finally are buried in some neglected spot to become the bogies and ghosts of superstitious fancies. Their lot of late has, however, been much ameliorated. The lash is practically abolished, and the interest of the owners compels them to be more lenient and less exacting. The total extinction of the slave trade has taken away the only sources of supply of labor, and though humanity be silent, selfishness induces a more careful preservation of the only labor existing. In former years a slave could readily treble his cost in five years, and as there was a constant entry of negroes, the planter could readily replenish his force. It was cheaper to work the slave to the verge of death than to preserve him carefully at a producing age. This is all past now, and sad as may seem to be the condition of the negro, it is immeasurably better than some twenty years ago.

I have spoken thus far only of the negro laborers and of the Chinese. Turning to the whites, I must say that few are found in the list of farm laborers. There are some, however, who are engaged in the same duties as the negroes. Their pay ranges from $17 to $20 per month, and supplied with rations similar in kind and quantity to that of the negroes. In the cities and small towns the whites are employed as cigar makers, carpenters, masons, clerks, coachmen, day laborers, and fishermen. The wages vary, and it is almost impossible to give more than an approximate estimate. Cigar makers are paid by the task, and these vary according to the size of the cigars, whether they be the small Concha or the large Imperiale; I think, however, that the daily earnings of a cigar maker would be from $2 to $3.50. Masons and carpenters earn from $3 to $3.50 per day; clerks in retail stores and shops from $12 for the new arrival to $40 for the trusted employe per month. Coachmen receive from $12 to $20 per month. The laboring 'longshoreman, etc., probably earns from $2 to $2.50 per day. House servants are almost exclusively colored, and their wages are more fixed. A cook receives from $20 to $25; maid of all work, from $18 to $22; washerwoman, from $25 to $35 per month. Porters, who are generally peninsular Spaniards, earn usually about $34 to $40 per month, gold. All the previous amounts are understood to be paper or Spanish banknotes, which to-day are at a large discount, the current rate of the premium on gold being 102 per cent.

PRESENT CONDITION OF CUBA.*

I have the honor to transmit herewith a copy and translation of a letter that first appeared in the Spanish newspaper *Las Novedades*, of New York, on the 16th instant, and is republished in the *El Triunfo* of this place of to-day. The writer, Mr. José Silverio Jorrin, is a native of Cuba; he left the island in 1869 for political reasons, and has since resided in Europe. In the first Cuban elections for the Spanish Cortes, 1879, he was elected a senator from the province of Puerto Principe. His first visit to Cuba in twelve years was a few months ago, and upon his return to Spain, via New York, he published in the latter place this letter, in which are expressed his opinions upon the present social, political, agricultural, and economical situation of the island.

As regards the social question, he appears to be satisfied that the process of emancipation is going on successfully; he observes also many improvements in the interior adminis-

* From a recent report by George W. Roosevelt, U. S. Consul at Matanzas.

* Although the Consul has given the duty on American hams at $8.35 per 100 kilos, it evidently should be $18.35 per 100 kilos.

† Report by Consul Roosevelt, of Matanzas.

* By Consul General Henry C. Hall, of Havana, as lately reported to the Secretary of State.

tration of plantations, and in the machinery, apparatus, and methods for manufacturing sugar—all of comparatively recent introduction. In other respects he finds the situation of the island deplorable, and he calls upon the Government of Spain to apply the remedy immediately, otherwise he believes its material prosperity and civilization will disappear forever.

The importance given to the dependence of Cuba upon the United States, the only remaining market for her principal staple, is worthy of attention, as are the fears expressed that the development of sugar production in the United States will, at no distant day, complete the ruin of the material interests of the island, and the measures he recommends that are to annihilate effectually the threatened competitive production before it shall have acquired great proportions. He suggests to the Government of Spain not to waste its time and diplomatic prestige in attempting to negotiate a treaty of commercial reciprocity with the United States; on the other hand, he recommends, substantially, the discontinuance of the present discriminating duties existing in Cuba, an assimilation of its tariff with that of Spain, a reduction of customs imposts and other measures tending to reduce the cost of production on Cuban plantations, and, consequently, the price of the sugar to the consumer in the United States.

The financial distress which now afflicts the agricultural and economical interest of Cuba, to which allusion is made in Mr. Jorrin's letter, cannot be attributed altogether to the late insurrection; it is, beyond a doubt, due principally to the results of the past twenty years' rule, under the old colonial system, which Spain, notwithstanding its completely changed commercial dependence, still attempts to maintain in Cuba, making this island the pivotal point of a commercial system having for its aim the protection, at the expense of Cuba, of Spanish agricultural, manufacturing, and shipping interests, and, through the interposition of a discriminating tariff, compelling her, while depending solely upon the United States as the only important market for her exports, to purchase her imports in Spain or in countries from whence they can be brought to the island in Spanish vessels.

Were Spain able to furnish a national market to Cuba, a discriminating tariff would be possible; because the protection here intended would be reciprocal, and it would act equally on production and consumption through her whole commercial system; the result would be similar to the protective system of the United States, by which Louisiana sells and buys in the Union. But, with Spain and Cuba, the case is not parallel; for Spain, at the utmost, does not to-day consume more than 5 or 6 per cent. of Cuba's products, leaving the balance to be sold in foreign markets, of which the United States takes nearly the whole.

Cuba has, therefore, become commercially a dependency of the United States, while still remaining a political dependency of Spain; the economical necessities of the island attract her toward the United States, while the origin, language, customs, religion, and traditions of her people enforce her political ties toward Spain. This conflict between material necessity and sentiment is probably the principal cause of the distress now prevailing in Cuba, and it requires but little foresight to perceive that this conflict must terminate either in complete commercial assimilation with the United States, or, as Mr. Jorrin predicts, in the ruin of her material interests and disappearance of her civilization.

CONTRIBUTION TO THE HISTORY OF THE ALEUTIAN ISLES, OR ALEUTIA.

By ARTHUR B. STOUT, M.D., San Francisco, California.

IN the course of the year 1874, the California Academy of Sciences received the donation from the Alaska Commercial Company, of San Francisco, of two skeletons or mummies. These specimens were two from a collection of a dozen or more which were by them presented to the Smithsonian Institution at Washington. A report upon these latter was published by the Smithsonian Institution, and written by W. H. Dall, U. S. G. S., in 1878. To this very valuable essay on "The Remains of Later Prehistoric Man," I refer, with great pleasure, for many important details omitted in this paper.

The two mummies in question have remained in my care, as Curator of the Department of Comparative Anatomy of the Academy, since 1874, and, except to open the cases which contained the bodies, to disinfect and carbolize them, I have not until now ventured to study them. But such is the increasing interest in anthropology; in the prehistoric condition of man; his evolution; his ethnologic and archæologic history, that I have thought it important to disturb these remains and offer the work for comparison with that of other similar researches.

The source whence these mummies was procured is best described by quoting as follows from the report of Mr. Dall:

"The most celebrated of these burial caves was situated on the island of Kagamil, one of the group known as the Islands of Four Mountains, or Four Craters. This group is not at present inhabited, except for a short period during the hunting season of each year.

"I visited these islands in 1873, but as the shores are precipitous and as there are no harbors, the weather was too boisterous to permit us to remain in the vicinity. Even if we had landed, it is probable that we could have done little without a guide.

"The traders in the islands were aware of the existence of this cave and its contents, and one of them, Capt. E. Hennig, of the Alaska Commercial Company's service, had several times attempted to reach it unsuccessfully. In 1874, however, the weather being quite calm, and the presence of a hunting party, which he was taking away from the island, enabling him to find the cave without delay, he visited it and removed all the contents, so far as is known. On their arrival at San Francisco, the Company, who had instructed their agents to procure such material for scientific purposes when compatible with the execution of their regular employment, with commendable liberality, forwarded them to the National Museum at Washington. Two of the mummies were given to the California Academy of Sciences, but all the rest were received by the Smithsonian Institution. It is unfortunate that but few details were obtained as to the exact disposition of the bodies, or mummies, in the cave; the situation and form of the latter, and other particulars which would have had great interest. From accounts received from Father Innokenti Shayesnikoff, previously, I am led to infer that the cave is situated near the shore at a point where the coast is precipitous and without a beach, the landing being on large irregularly broken fragments of rock, the tables from the cliffs above. The island contains active volcanoes, as I am informed, and in the immediate vicinity of the cave are solfataras, from which steam constantly arises, and the soil is said to be warm to the touch. The rock is of a whitish and ferruginous color and sharp grain. Specimens examined by Dr. Endlich, of the Smithsonian Institution, prove to be a silicious sinter, containing a little alumina and soda, and some hydrous sesquioxide of iron. In the spectroscope traces of lithium and potassium and possibly a trace of lime were seen.

"From this, and from the fact that the atmosphere of the cave is said to have been quite hot, rendering it uncomfortable to remain in, it is possible that the cave itself may be the crater of a small extinct solfatara.

"With regard to the age of these mummies, as they may be styled, I was informed, in 1871, by several of the more intelligent natives, that they fixed the date of the earliest interment in the following manner: It occurred in the autumn or winter. During the following spring the first Russian ever seen by the natives of the Four Craters arrived in the vicinity. These may have been Trapeanikoff's party, which left Kamtchatka in 1758, but did not reach Umnak until 1760; or they may have been that of the infamous Pushkareff; or possibly of Maxim Lazeroff; but in any case, they can hardly have been the expedition of Behring.

"In 1757 Ivan Nikiferoff sailed as far east as Unak, being the first Russian to do so, except those of Behring's Expedition, who did not land on any of the Andreanoff group, though in 1741 they saw the shores of numerous indeterminate islands from a distance. The earliest date, therefore, which we can assign to these remains would be 1756, making the oldest of them about one hundred and twenty years old.

"At all events they possess great interest as the best preserved relics of the state of things as they existed immediately prior to the Russian occupation and when their pursuits and handiwork had not been modified by the introduction of any of the adjuncts of civilization."

The two specimens were preserved, each in an excellent case with glass cover. No implements whatever were found. No. 1 contained the skeleton of a man, and No. 2 contained the skeleton of a woman. This latter had been disturbed and the strappings of the package were off. The former was yet intact and its original binding unbroken. The odor was strong and penetrating, not that of putrefaction, but like creosote; not unlike that of buffalo robes smoke-dried by the North American Indians in their wigwams, only much more pungent. Large quantities of the larvæ of insects were in the cases, showing that animal life had been busy in the bodies.

The hope was now entertained that we possessed, perhaps, the remains of the distinguished toyon, or toygon, Kat-haya-Koochak, the renowned Aleut chief, famous for his courage, enterprise, riches, and love of family. (See Dall's Report, p. 9.) But this chief is described as "a very small man," while our chief measures 5 feet 9 inches in the bones. Two units being allowed for skin, flesh, and general shrinkage between vetebræ, would give 71 inches, or 5 feet 11 inches. His cerements are of the simplest kind, while one of the mummies described by Dall was clothed in the finest wrought and most costly fabrics. Hence ours cannot be the remains of this great Aleut.

The strappings of the package being taken off, a large sealskin envelope, carefully wrapping the bodies and much deteriorated by time, was unfolded. Within this, and covering closely the anterior part of the body, was the spoiled and disintegrated skin of some large bird, some of the feathers of which were still clinging to the rotted fibers of the skin. The bodies now exposed were yet in some places covered with the skin; in other parts the bones were entirely denuded. The skin was dark colored, desiccated, and of pachydermic toughness, requiring the saw, rather than the knife, to divide it. It was also perforated with numerous little round holes made by some boring insect. No traces of viscera remained, but the thoraces were not opened. Whether evisceration had been practiced at the time of embalming, or whether the intrusive animal life had consumed them, was not easy to determine, but the crania were entirely empty, and we can hardly believe that the embalmer removed the brain. The limbs were carefully and most compactly folded on the body, apparently to make the embalmed package as tight and small as possible, and might be laid flat or placed in a sitting posture. The heads were depressed so that the chin settled down into the pit of the neck, and the lower maxillæ being thus forced down, the mouths were wide open.

It is regrettable that photographs of these mummies cannot be offered, as in the picture given by Mr. Dall the limbs are dislocated and distorted, failing entirely to express any idea the embalmers may have desired to perpetuate, or the admirable care and solicitude in their work. The thighs were brought up and doubled close upon the abdomen; the legs folded snugly upon the thighs, and the feet pressed sharp down backward. The arms were laid symmetrically on the thorax, and the forearms bent upon the arms, the hands not crossed in repose upon the chest, but with the fingers curved over the front of the shoulders.* Thus much for the aspect of the bodies.

What may be the origin, we may ask, of these people? Whence came they?

It is not probable that an autochthonic race existed in these Aleutian Islands. Such rude, inhospitable, storm-beaten regions were not likely to be the cradle of a special tribal birth. Regarding these islands as they appear on the map, the idea is forced upon the mind that at some remote epoch the two continents of Asia and America formed one territory. The volcanic nature of the entire region indicates a vast change of the earth's surface by which the continuity of the continents were destroyed. The long promontory of Aliaska extending from Alaska, nearly touches the easternmost island of the Aleutian chain. A long succession of wild eruption-torn islands in a crescentic line crosses the sea, thence to the Kamtchatkan coast; the whole group, hung like a grand festoon of gems formed by Titan hands and resplendent with the illumination of volcanic fires, appears suspended from shore to shore, to adorn the approaches to the Straits of Behring, or rather, in a military view, like a vast circumvallation of fortresses to defend their entrance from invasion. But the Arctic Ocean has its own defenses and needs no such gigantic ornament. Only the ruined abutments now remain of the "bridge," which some author calls the Aleutian Islands, by which migrations of peoples passed from continent to continent, and the bridge was the segment of a circle.

This view seems sufficient without seeking a Malay, Japanese, or Chinese origin for the natives of the Aleutian Isles. Their progenitors were an autochthonic race. It is a prevailing opinion that a vast invasion of wild tribes from the far northwest poured down upon the ancient Mound Builders of North America, sweeping them away from their copper mines on Lake Superior, destroying their temples, burial places, and fortresses in the valleys of the Ohio and Mississippi, and exterminating their race or driving them back whence they originated, across Texas into Mexico and Central America, leaving no vestiges of them but their teocallis and their mounds. How immense must have been such an invasion and how persistently continuous in its course, to have so completely obliterated the numerous and extended populations of the Mound Builders, possessed as they were of the defenses and weapons of a high civilization! The great nomadic incursions recorded in history, like that of Genghis Khan into Europe, become inconsequential in the comparison.

If such things did occur it must have been at an epoch long anterior to the present condition of the "far northwest." Earthquake and cataclysm, the battles of fires and waters must have created greater disturbance with far more destructive and radical invasions than any human agency could have accomplished. The present state of the physical geography of this "far northwest" utterly precludes the possibility of any such invasions, fulfilled by barbaric hordes. Neither time nor circumstance could accomplish, under such physical conditions, so gigantic a work and have left not even a mound or a mile-stone to mark its route.

There must have been upheavals of volcanic peaks with their boiling lava chimneys forming mountains merged in the waters with only their summits visible above the ocean, like the island of the "Four Craters," and again a subsidence of territory from the caving in of the vast subterranean cavities emptied of their seething contents. With all this must have occurred an inundation of waters, in which great cataclysm the waters of the Atlantic and Pacific Oceans blended, the grand Gulf Stream of the former passing through the Arctic Sea by the Straits of Behring with the equally grand Pacific Black Stream, or Kuro Shiwo. Before this epoch the ancestors of the Esquimaux in America and the Koriaks, the Chukches, or Tungusian Tartars of Asia may have traded, and dwelt in their igloos together.*

Let all this be as it may, at the time that the Russians discovered these islands, the natives of the different groups spoke different languages, and hence we may infer that the inhabitants of the various groups were the remains of migrations from both America on their east and Asia at their west, as they again coalesced, and were regenerated from the lapse of time.

Some question has been made of the derivation of the name Aleut, and even suggested that it was a term of contempt of the Russian explorers and fur hunters for the islanders (see Dall's Report), but we find in the work of Wm. Coxe, A.M., London, 1780, "Russian Discoveries between Asia and America," published just 100 years ago, that the word Aleut is Russian, meaning "*a bold rock*." Such is the distinctive character of all the islands, and hence seems peculiarly adapted as their title.

A glance at the grouping of these islands is important to our purpose. 1. At the northwest of the semicircular girdle are Behring's Island and Copper Island, where large outcroppings of copper indicate an abundant mine of the metal, and possibly point to a line of copper vein from the shores of Lake Superior over the region of the Coppermine Country in Alaska to this deposit. We may remark in passing, that it is surprising that with this free surface deposit of copper at this locality, no copper implements have been discovered among the relics of the old Aleuts.

2. Say S.E. are the Aleutian Islands proper, viz.: Attak, Semitski, and Shemiya, W.N.W. to E.S.E.

3. Then, N.E. some six islands, the Andreanoffski group, or *Ostrova*, meaning islands, and

4. The Lyssie Ostrova, or Fox Island, stretching S.E. and N. by E. almost to the Alaska promontory, and the last discovered at the epoch now alluded to.

This last important group contains Umnak, Ounal-aska, or Aghunalaska, the principal depot of the Alaska Commercial Company, with St. Paul and St. George further to the north, and also the barren deserted isle, one of the "Four Craters" or Kagamil. In a cave of this island, a bold bluff, mid-ocean, storm-lashed in its Arctic clime, but yet still seething and steaming with solfataras and volcanic heat, is the mausoleum of our Aleut Chief and all his family. Here we meet him and his progeny on a desolate fragment of the ruptured territory which once united the two great continents—the monumental stone of the ruin not only of the land, but the division of unnumbered peoples. Imagination may picture, but cannot surpass the grandeur of the truth. Another division of the Aleutians is:

I. The Kaniagmuts; and II. The Aleuts; III. The "Vaygeli," or Spectral Outlaws. These are supposed to be the original inhabitants who disdained any outside authority, refused to be converted to Christianity, and consequently live, if such really exist, as independent natives or banditti in the interior inaccessible mountains.

The Vaygelj may possibly be only the predatory animals which come at night and carry off the islanders' provisions. But the mythical or legendary belief of the natives points distinctly to ancestral sagas which have been orally handed down to them from generation to generation. We may infer either an extinct prehistoric race with which the present family has no lineal descents, or we may refer the legend to the earliest progenitors of present tribal groups.

As regards our present mummies they are undoubtedly too recent, whether we allow them 120 years, or about 340, according to Captain C. L. Luneuski, to consider them in the light of *prehistoric* remains, or concede to them Mr. Dall's distinction of "Remains of Later Prehistoric Man." Capt. Luneuski has been a resident of the Aleut Isles for many years, connected with the Alaska Commercial Company. He antedates our mummies many years to the Russian discovery and conquest of the islands. His intelligent studies, predicated in part on the diversity of their languages, gave to the Aleuts a divided descent, in part from the Esquimaux of America and the Mongoloids of Northeastern Asia.

* In regard to Aleutian burial ceremonies, says Coxe, page 178: "The bodies of poor people are wrapped in their own clothes, or in mats, then laid in a grave and covered with earth. The bodies of the rich are put, together with their clothes and arms, in a small boat made of the wood driven ashore by the sea; the boat is hung upon poles placed crossways, and the body is then left to rot in the open air."

* The pent-up waters of the Arctic Ocean burst through the Behring Strait and overwhelmed the ruins left from volcanic fires—as the waters of the Nevadas by a thousand floods at some epoch tore through the Golden Gates. As a further illustration of this subsidence and upheaval it is recognized that the waters of the Arctic Ocean once penetrated the American continent as far—if not still farther—as Great Slave and Athabasca Lakes, and that that long chain of lakes in the interior of the continent are only the vestiges of the departure of the greater sea. In the same manner as it is conceded that Siberia was once covered by the Arctic waters, the remains of which are the Lake Baikal and the Caspian Sea, while such great rivers as the Lena, Yenesei, and Anadyr now drain the mountain lilies back to the retreated ocean.

The Russian explorers and fur hunters of importance in the discovery of the various islands were:

Behring in	1728
Behring and Tcherihoff in	1741
Nevodsikoff in	1745
Serebranikoff	1753 to 1756
Trapesnikoff	1758 to 1760
Bethshevin....reached Alexau, furthest island east.	
Tolslyh	1760 to 1764

These navigators, with few exceptions, treated the natives with great barbarity. Many of their expeditions were failures and their vessels wrecked; several of them were burned by the natives. All of them suffered great hardships. Of their vessels, says Mr. Coxe: "Most of them which are equipped for these expeditions, are two masted; they are commonly built without iron, and in general so badly constructed that it is wonderful how they can weather so stormy a sea. They are called in Russian *skitiki*, sewed vessels, because the planks are sewed together with thongs of leather. Some few are built in the river Kamtchatka, but they are for the most part constructed in the haven of Okhotsk. The largest are manned with seventy men, the smaller with forty men."

Hence the Aleuts, as naval constructors, with their elegantly and artistically built bidarkas and baydars far excelled in skill their abusive invaders. But these latter had guns. In their warfare they displayed much military invention. To avoid the guns they constructed large double screens made of sealskins, stuffed between with dried fiber of grass, and advanced toward the vessel, pouring upon its deck their missiles from behind, and finally setting fire to it with sulphur found in their island craters.

Inside of the war faculty, and touching the home and domestic idea, wild to our appreciation as it may be, we are taught by the elaborate and exhaustive report of Mr. Dall on the mummies from our "Four Crater" cave, that their art work by their women, whether the result of nearly lost hereditary culture, or of native original industry, patience, and invention, was high in its excellence. (See report of Case 17,478 in the Museum of the Smithsonian Institution, page 11 of Dall's Report, cited.) This ethnological description is rich in its suggestive text. How did the Aleuts learn to make these extra fine fabrics, with nothing but Aleutian raw material? Our present chief is silent, but he left head enough to explain it all.

In brief, from all this we can derive enough to feel sure that this ancient folk, after their own way of thinking, education, and old civilization, possessed a high sense of religion, believed in a future life, as proved by their devoted funeral ceremonies, worshiped a divine Creator; appreciated the love of home, were profoundly impressed with the devotion due to the family bond. Still further may we trace the illustration, for if cranial capacity and form can be regarded as the index of mental ability, we have shown that the eaglelike tenant of his northern fastness was worthy of his eyrie. Again, will it appear that here on the confines of nations, in the same tomb, the two great types of the human races, the dolicocephalic and the brachycephalic heads, were together embalmed.

When the Russians discovered the islands the Kamtchatdale interpreters, who could speak the language of the Aleut, could not understand the dialect of the natives of the Fox Islands. To obtain their objects they resorted to the cunning device of utilizing the paternal affection of the chiefs. Under pretense of keeping the peace and insuring the tribute of sealskins, exacted by the Russian Government, they caused the sons of toygons, or chiefs, to be delivered to them as hostages. These they sent to Kamtchatka to acquire the Russian language. The celerity and aptitude with which these boys learned to interpret went far to prove the natural intelligence of the people so more than barbarously treated by them as barbarians. As reward for their services they converted them as usual to Christianity, but piously took their skins; nor did they fail to appropriate their women, which, as "*ante Trojam fuit*," was always the cause of their wars with the Russians. Their hospitality, kindness, and indispensable aid to the invaders of their realm were devoted and unceasing, until deceived, as were other Indians by Cortes and Pizarro, by lust, and the "*auri sacra fames*."*

The existence of three languages, or perhaps dialects, may be inferred, for Coxe states (page 264), that the inhabitants of Unalaska were called Khigoiaghi; those next eastward to Unimak were named Kighigusi; and those of Unimak and Alaxa, were styled Kalaghayekiki. In 1741 Behring sighted and Steller first landed on the American continent. (Coxe, page 277.)

The Russians conquered Kamtchatka in 1696, taking 45 years to discover the way from shore to shore. As the islands then were peopled, so in probability were their languages introduced, by the various tribes of refugees in quest of safety in flight, or as hunters of game from the shores of both continents, or as they mingled before the continents were cleft apart.—*Kansas City Review.*

THE RIGHT TO LATERAL SUPPORT.

THE case of Angus & Co. *vs.* Dalton and the Commissioners of Her Majesty's Works, which has recently been decided in favor of the plaintiffs by the House of Lords, after a protracted litigation extending over more than five years, has finally settled a much-vexed and subtle but important question, viz.: how far, and under what circumstances, a building, standing at the extreme edge of the proprietor's land, has a right to be supported by the adjacent soil of his neighbor.

The circumstances under which the problem arose for solution were somewhat peculiar. For nearly a hundred years there had existed at Newcastle-on-Tyne two houses standing side by side, one of which belonged to the plaintiffs in the present action, and the other of which was acquired, shortly before the commencement of the action, by the Commissioners of Works. The plaintiffs' house was built close up to the other, but quite independently of it, and on the side where it adjoined the other, it had no external wall of its own, but was closed up by the defendants' wall, though it did not take any support from it either for walls or floors. In the year 1849 the plaintiffs' house was, by extensive structural alterations, converted into a carriage factory. These alterations consisted in taking out all the internal walls, in strengthening a chimney stack which abutted on the defendants' wall, and in converting the stack into a pier to support one end of a girder which was to take the weight of the upper floors, in place of the internal walls removed. One-fourth of the weight of the whole internal structure was thus made to rest upon the chimney stack which ran up against the defendants' wall. In the year 1875—twenty-seven years after the alterations above described—the house which we have spoken of as the defendants' was acquired by the Commissioners of Works, and Mr. Dalton was employed by them as contractor to pull down the old building and to erect a new Probate Office upon the site of it. The building was taken down in due course, leaving the plaintiff's coach factory open on one side, and exposing to view the chimney stack, on which the support of the interior of the plaintiff's building depended. The excavations for the foundations were then proceeded with, and carried to a considerable depth, and a substantial pillar of the subsoil, which consisted of a tenacious clay, was left to support the stack. Had this pillar of clay remained in the same condition as when it was uncovered, it would have been amply sufficient to give the support required, but the clay on exposure to the air speedily lost its moisture, crumbled away, and let down the chimney stack, and with it the greater part of the plaintiffs' factory.

Under these circumstances the plaintiffs brought their action against the contractor, who, if any one, was directly responsible for the catastrophe, and against the Commissioners of Works, for whom the contractor was acting. The main question to be determined was, whether the plaintiffs, under these circumstances, had any right whatever to have their building supported by the adjacent land of the defendants. There is but little doubt that such a right is not, like the right to support of land in its natural state, a natural right of property. The right must have been acquired, if at all, and independently of legislation, either by prescription or by a grant, express or implied, from the owner of the adjoining soil. The acquisition of a right by prescription depends upon the right having been enjoyed "time out of mind," and as it was shown to have dated back only twenty-seven years, it could not have been acquired in this way. There was no pretense of any actual grant of the right ever having been made; in fact it was shown that no actual grant ever was made. The right claimed could, therefore, be supported only on the ground of an "implied grant," a phrase, perhaps, not very intelligible to the non-legal mind. The fiction of an "implied grant" was raised by the judges many years ago, to quiet the enjoyment of such rights when otherwise they would have failed. It took the form of a direction to the jury, that they should presume the existence of a grant which had been lost, where the evidence showed the right had been enjoyed twenty years, and where there was no evidence to disprove the existence of such a grant. That is to say, after twenty years' uninterrupted enjoyment a grant was implied, unless it was shown in a positive manner that no such grant could have existed. In the present case, however, it was actually shown that no grant ever did exist. But by the application of another legal maxim, "Qui non prohibet quod prohibere potest assentire videtur," *i. e.*, that a person who does not prevent the enjoyment of a right which he has the power to prevent, must be taken to assent to such enjoyment, it was held that the evidence of the non-existence of a grant was insufficient to show any protest on the part of the adjoining owner. It was, therefore, held that the enjoyment for twenty years and more was sufficient to give the plaintiffs the right for which they contended. It was further held by the Lord Chancellor, that the easement of lateral support comes within the Prescription Act, which says that certain easements may be acquired by prescription after twenty years' enjoyment, notwithstanding proof that they had not existed "time out of mind." We do not understand, however, that any of the other legal authorities supported this view.

It is somewhat surprising, considering the subtle and highly technical grounds on which the arguments and judgment proceeded, that the defendants did not raise what seems to us to be the true nature of the right claimed. It was admitted that the pillar of clay which was left by the excavators was, in the state in which it was left, amply sufficient for the support of the stack, and that the accident arose from the drying action of the air upon the clay when exposed. The right claimed, therefore, in this case resolved itself into a right to have the supporting clay covered up by the defendants' soil, so that its moisture, and consequently its supporting qualities, might be preserved. We do not think that the plaintiffs could have claimed a right to have the protection of defendants' soil to keep their clay wet, any more than they could have claimed a right to have the protection of the defendants' wall to keep their building dry. The point, however, was not raised, and the decision proceeded as if the right to support alone were in question.

According to the law as it now stands declared, a building erected upon the edge of the proprietor's land has, after twenty years, a right to the support of the adjoining soil, and this however shallow may be the foundations. Thus, though the foundations be merely "scratched in," as is the practice with speculative builders of the present day, after the building has stood twenty years the proprietor of the adjoining land will be debarred from excavating it, even to a small extent, except at his own risk. The only way in which he can effectually prevent the acquisition of the right is by digging a hole in his land during the twenty years, and actually letting down his neighbor's building. On the other hand, the building may have its foundations laid deep and solid, yet, until the lapse of twenty years, the proprietor has no security that it may not be brought about his ears, except in the forbearance of his neighbor. If his neighbor, as sometimes happens, put up next to him a heavy building, which by its weight disturbs his foundations and cracks his house, or lets it down, he has a right to compensation; but if, within twenty years, his neighbor maliciously excavates and produces the same effect, he has no such right.

But for the forbearance of which we have spoken, a state of things such as this would have long ago become intolerable in the metropolis and other large towns. As it is, this forbearance cannot always be relied on, and now that the present state of the law is definitely determined, the question arises whether or not it should not be amended by the action of the legislature. The course which may be proposed is that by laying the foundations at a certain depth, varying perhaps according to the neighborhood and the weight of the building, an immediate right to the support of the adjoining land should be gained. Another plan which suggests itself is that a person proposing to build along the edge of his land should give the adjoining proprietor notice of the nature of the proposed building and the proposed depth of foundations. If no objection be made the work could proceed, and the right be immediately acquired. If objection be taken, and the parties fail to come to terms, the matter should then be submitted to the district surveyor, or to an arbitrator agreed on by the parties, who should award upon the matter and state how much, if any, compensation should be paid to the adjoining proprietor in respect of the diminished value of his land by reason of the depth to which he may excavate upon it being limited. The compensation being paid by the building erected in accordance with the award, the right would then be acquired as before. The rights of the parties would thus be at once finally ascertained and determined, without the lapse of twenty years and the intermediate uncertainty. Some such solution of the difficulty seems to be called for, whenever an overworked legislature can find time to turn its attention to the subject.—*Engineering.*

A NIGHT BALLOON ASCENT.

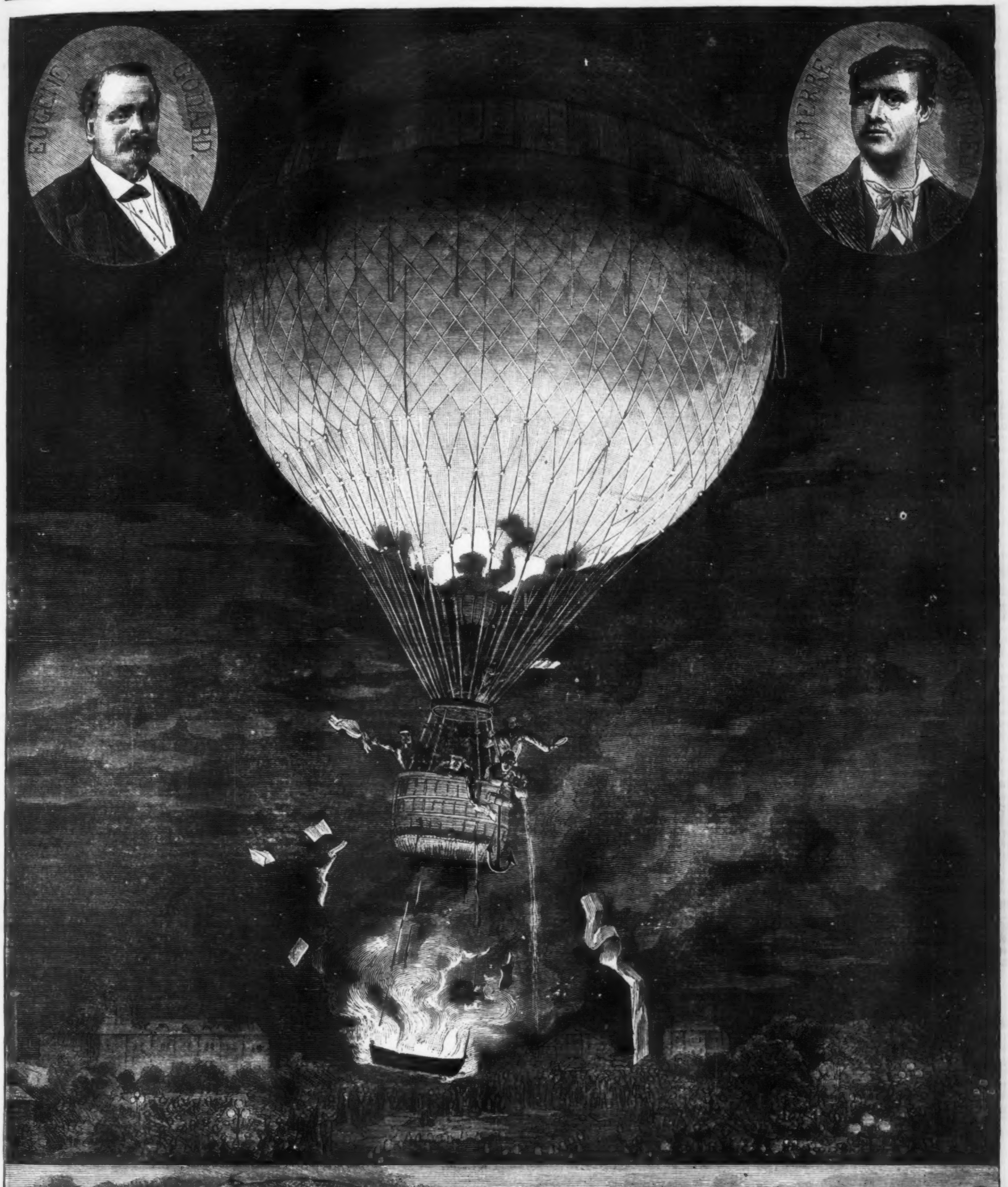
M. EUGENE GODDARD is well known as a daring and experienced aeronaut, since 1850, when he made his first ascents, during the Italian campaign, but his fame became widespread in 1870 and 1871, at which time he was director of the Parisian Balloon Mail and Passenger Service. He designed all the balloons that carried letters and the leaders of the government (among others Leon Gambetta) from the besieged capital. Mr. Goddard's wife superintended the sewing of the silks of which the balloons were made. One of Goddard's brothers, Jules, left Paris in the balloon Montgolfier, carrying about 700 pounds of mail and about 920 pounds of other matter. The Vauban, Christophe Colomb, Union des Peuple, and many other balloons successively left Paris, and naturally became an object for target practice for the German sharpshooters and an object of chase for the Uhlans, but not a single balloon was ever caught by the German soldiers. One balloon was carried to Norway in a few hours, and all the rest were landed safely, except one, which was never heard from. Mr. Goddard has made over one thousand eight hundred ascensions in Europe and America, without a single accident. His most celebrated trips are from Paris to Ostend (in four and one-half hours), from Paris to Spa, from Vienna to Austerlitz, and from New Orleans to Pittsburg.

On June 16, 1881, he made an ascension at Dresden, Germany, under the most favorable conditions of the weather, the heavens being clear and starry. His balloon, the Comet, rose at 11 o'clock at night, admired by thousands of spectators. The enormous balloon required 51,000 cubic feet of gas to fill it, and about six and one half hours passed before the filling was completed. It gradually began to swell and rise, as shown in the lower part of the opposite cut, and at 10 o'clock it presented its full form. At 11:45 Mr. Eugene Goddard and his young assistant, Mr. Crommelin, Count Luckner, a gentleman of great popularity in Dresden, and his friend, the well known artist, Von Boddieu, entered the car. After the signal for releasing the balloon had been given, the same soared upward gracefully and surely, presenting a view to the spectators below which will never be forgotten by them. The rays of a seventy-five element electric lamp, provided with parabolic reflectors, were directed upon the balloon, and followed the course of the same through the dark sky. As the balloon attained an altitude of about fifty feet it raised a large metal plate suspended from the car, and carrying quantities of colored fire, which was ignited at the moment the plate left the ground. This is represented in the accompanying engraving. The brilliant flames of the red and blue lights illuminated the car and the passengers so that their magnified silhouettes appeared on the illuminated body of the balloon, even after the same had reached a considerable height. The balloon gradually drifted toward the west, followed by the rays of the electric light, which alternately lost and found it. Unfortunately the colored fires on the plate or tray suspended from the car were of very poor quality, and extinguished in a short time, and Mr. Goddard ordered young Crommelin to climb down the ropes to the plate below and ignite fresh fireworks, but again the poor quality of the fireworks made the attempt to illuminate the balloon unsuccessful. Fortunately, and to the great relief of the occupants of the car, young Crommelin returned safely from his short but hazardous trip. At a height of about three thousand feet the occupants of the car drank a bottle of champagne to the successful completion of the trip, etc. The balloon reached an altitude of seven thousand five hundred feet, and after remaining at this elevation for about an hour and a quarter began to descend slowly, and finally landed on the grounds of Count Luckner as easily and safely as a train of cars stops at a station.

THE SPEED OF THOUGHT.

IT is not unusual to hear the expressions, "quick as thought," and "quick as lightning," used as if they were synonymous; but there is a vast difference, comparatively speaking, between them. The electric impulse is practically instantaneous over, say, a mile of wire; but, if we may trust the experiments of Helmholtz and others, the wave of thought requires about a minute to traverse a mile of nerve. An electric shock is felt simultaneously in every part of the body, but the sensations of touch and of pain occupy an appreciable time in making their impressions on the sensorium. The interval between the reception of an impression by the brain, and its perception by that organ, is, doubtless, inexpressibly short; but as we can only test the speed of thought by noting the time elapsing between the application of the cause of the thought and the exhibition of some indication of its reception, we find that the time occupied can be measured. Thus Hirsch, by means of a suitable apparatus, found that a touch upon the face was recognized and responded to by a predetermined signal operated by hand in one-seventh of a second. There is no doubt some loss in the purely mechanical operation of making the signal; but when the different senses are tested in this manner, and a mean taken of all the experiments, we find not only that the act of thinking is not so rapid as was imagined, but that the speed varies with different senses. Thus the sense of touch was found to respond in one-seventh of a second, that of hearing required one-sixth of a second to respond, and when the eye was tested, one-fifth of a second was occupied in recognizing the signal. The distances traveled by the nervous impulses in each of these cases was as nearly as possible the same, and it follows, therefore, that the recognition of them required more time in some cases than in others. Simple as it may seem, a number of operations must be performed by the brain in receiving and recording the reception of the impression. There is the transmission of the sensation to the brain, its recognition, and then the determining to make the signal, the transmission of the determination to the muscles, and the movement of those muscles. Hirsch showed, as explained above, that less time was required to recognize a touch than a sound, and that it took more time to see than to hear, but the question still remained as to what part of the time occupied was consumed in the act of recognition. Donders, by means of some very ingeniously constructed apparatus, solved the question. He found that the double act of recognizing a sound and giving the response occupied seventy-five thousandths of a second, of which forty thou-

* Their phallic customs are more worthy of leniency than are the morbid abuses of other people.



EUGENE GODDARD'S NIGHTLY ASCENT WITH HIS GRAND BALLOON, COMET.

sandths were occupied in simple recognition, leaving thirty-five thousandths for the act of volition. One twenty-fifth of a second was occupied in judging which was first of two irritants acting upon the same sense; but a slightly longer time was necessary to determine the priority of signals sent by different senses, as those of hearing and seeing. These results were obtained from a man of middle age, the young were slightly quicker; but the average of many experiments showed that the time required for a simple thought was never less than the fortieth of a second. From these experiments we learn that the mind cannot perform more than twenty-four hundred simple acts in a minute, and that the stories we have heard from persons rescued from drowning are simple exaggerations.—*Popular Science Review.*

THE SEWING MACHINE IN FRANCE.

THE new tariff, which fixes the duty on sewing machines at 6 francs per 100 kilogrammes (about $1.20 for each 220 lb.), will result in increasing largely the importation into France of foreign machines. This duty, which, especially on machines of American and English manufacture, is to-day from 72 to 84 francs per 100 kilogrammes (about $14.40 to $16.80 for each 220 lb.), will, on the taking effect of the tariff, which cannot be far off, reduce the duty at once to the figure above mentioned.

The result will evidently be an increased importation, which must lead to a fall in prices, as that is the natural effect of a more lively competition.

The French manufacturers, to whom the establishment of so inconsiderable a duty must be extremely grievous, as we have explained in a former article, will hold their own against their competitors, and will not only follow the current which leads to lower prices, but should, in order to sustain the struggle with advantage, make use of the resources which their recognized skill affords, to give to sewing machines of French manufacture such improvements and such solidity of construction as will always obtain for them the preference. In such a way only can they obtain success in a competition that may be truly called unequal.

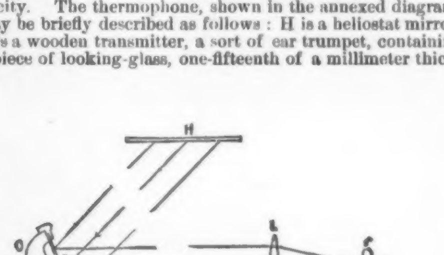
From the consumer's point of view there is no doubt that the public ought to be benefited by this state of things, and that the price of sewing machines will gradually diminish to such a figure as will admit of their universal adoption. By this means, let us hope that the time will soon arrive when the hesitation to employ sewing machines still existing in many families and factories will disappear.

It is well to remember that if we are slow, in France, to adopt the sewing machine in our families, it is not only that the high price is an obstacle, or that the old routine opposes the admission of a little machine, the good offices of which are fully recognized; it is mainly that not sufficient account is taken of the variety and importance of its services. In one word, the sewing machine is yet too little understood in France. Its introduction and use are, so to speak, too new among us. In many a minor French locality it has not yet even appeared, and even in the large cities there are plenty of people who still know but little of its use. The ideas of the present generation are not yet in consonance with the use of the sewing machine; but its influence is spreading, and little by little we are appreciating the economical advantages it brings us. More or less near is the time when every mother of a family will use the sewing machine to facilitate her labor, shorten her evening tasks, and increase, without fatigue and without expense, the various products of the needle. The use of the sewing machine, already so greatly developed in the United States, in England, and in Germany, will eventually reach the same proportions in France, then in Spain, and Italy, and in many countries still behindhand in this respect. It is certain that since the sewing machine has become an instrument of labor easy to manage, elegant, and convenient, it is being more and more known and employed.

We must add, therefore, that if there is anything to lessen the regret we experience at a reduction of the tariff, which is undoubtedly a serious blow to our French manufacturers, it is the hope that the rapid decrease in price will quickly bring about a general adoption of the sewing machine in our families.—*Journal de la Machine a Coudre.—Sewing Machine Advance.*

THE THERMOPHONE.

WHILE Messrs. Bell and Tainter were arriving at their remarkable results in photophonic science in the United States, Mr. Mercadier, pursuing his researches on the radiophone, was making in France analogous discoveries, which had for their result the production of what he has styled the thermophone—an apparatus which transmits speech like the photophone, but without the use of selenium or electricity. The thermophone, shown in the annexed diagram, may be briefly described as follows: H is a heliostat mirror; C is a wooden transmitter, a sort of ear trumpet, containing a piece of looking-glass, one-fifteenth of a millimeter thick,



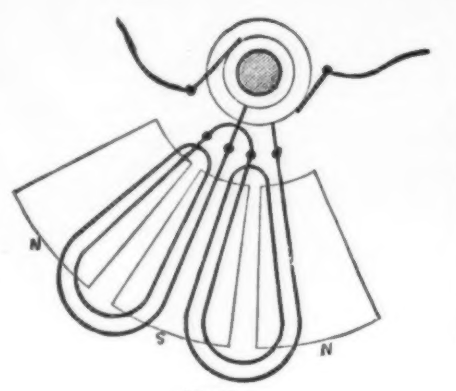
MERCADIER'S THERMOPHONE.

P. A thin sheet of mica, *p*, is fixed beneath this mirror, and, between the two, there is a reservoir of air, *r*, which regulates the action of the voice. E is the mouth-piece, before which the speaking is done.

The luminous ray, reflected to P, is directed from thence toward the receiver, traversing on its way a lens, L, sixteen centimeters in diameter, and placed at a distance of fifteen or twenty meters from the receiver, from which it is separated by two glass doors. *t* is the thermophone, properly so called, formed of a small glass tube, containing a thin sheet of smoked mica, *m*, and connected, by a rubber tube forty to fifty centimeters long, to a ear-trumpet, A.

THE NEW CONTINUOUS CURRENT DYNAMO-ELECTRIC MACHINE OF HEFNER-ALTENECK.

IT will be remembered that Siemens' alternating machine, which was described about two years ago, is composed of two circular rows of electro-magnets having opposite poles, and forming a series of magnetic fields, between which revolve galvanometric helices, or bobbins without core. The diagram, Fig. 1, wherein are represented only two of these galvanometric helices, recalls the principle of the machine N, S, and N are the poles of the electro-magnets situated at one of the sides of the machine. These are alternately north and south, and to each of them is opposed a pole of contrary polarity, so that the successive magnetic fields are inverse. The bobbins without core are represented at the moment when they are half in a magnetic field and half in the following. At this instant there is developed in half of



(FIG. 1.)

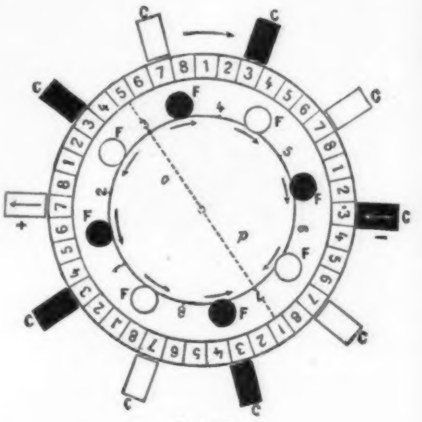
the wire an ascending, and in the other half a descending current, and these two currents combine. When the bobbins are entirely included within the corresponding magnetic fields the production of currents is arrested, and then it resumes again in each bobbin in a direction opposite to that which it had immediately before, and so on. The bobbins are coupled in such a way that, at the same instant, the current has the same direction in all; and the extremities of the wire are led to two collectors, the brushes of which consequently collect an alternating current.

Mr. F. V. Hefner-Alteneck, the eminent engineer of the house of Siemens & Halske, has just modified this apparatus in a very simple and ingenious manner so as to convert it into a continuous current machine. This modification is based on the use of a number of bobbins which is less than that of the magnetic fields, and its principle is as follows: Instead of collecting currents which are generated successively at two fixed points, there are collected currents which are produced successively at different points of the machine.

bins, all the bobbins which approach a magnetic field of the some color will produce in the circuit a current of the same direction, and all those which approach a field of contrary color will produce a current the inverse of the first.

On examining the figure and supposing all the positions possible for the bobbins (¹), we shall always be able to find a line, *o p*, dividing the series of these bobbins into two halves, each traversed by a current of opposite direction. The distribution, in fact, will be like that which has place in the Gramme ring; and it may be seen that, with this arrangement, in order to collect a continuous current, it will suffice to have two contacts which are always at the extremities of the line, *o p*, whatever be the position of the latter.

In order to arrive at this result, Mr. Hefner-Alteneck employs a commutator analogous to that of ordinary dyna-



(FIG. 2.)

mo-electric machines, and which is represented in detail in Fig. 3. For a machine possessing, as we have supposed, 10 pairs of electro-magnets and 8 bobbins, the commutator is composed of 40 insulated plates, *t*, *t*, which, in the diagram (Fig. 2), are represented by the 40 spaces numbered from 1 to 8. These plates are divided into 8 groups, the first including all those marked 1 in the diagram; the second, all those marked 2; the third, all those marked 3, and so on. The five plates of each of the eight groups communicate, through the medium of wires, *d*, *d* (Fig. 3), with the same metallic ring; so that the axle carries, therefore, 8 like rings each communicating with 5 plates. Besides this, between the successive bobbins and from the conductors by which they are connected, there issue wires whose points of attachment are indicated in the diagram and designated by the numbers 1 to 8. Each of these wires communicate with one of the groups of plates above described. Wire 1 communicates with group 1, wire 2 with group 2, and so on. The current

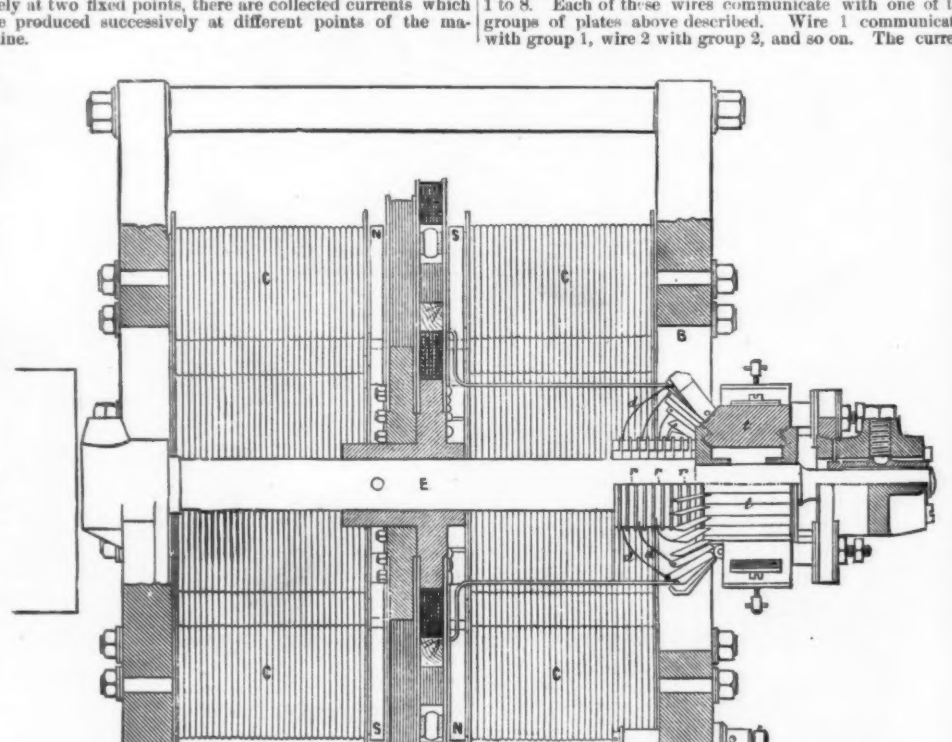


FIG. 3.—HEFNER-ALTENECK'S NEW DYNAMO-ELECTRIC MACHINE.

Fig. 2 shows a diagram designed to make the operation of the machine theoretically understood. The rectangles, C, C, C, 10 in number, and alternately black and white, represent the magnetic fields of inverse direction as they are established in the Siemens machine. The disks, F, F, F, 8 in number, and likewise black and white, represent the bobbins, wound one in one direction and the next in another, and which revolve in the magnetic fields. The circle marked with the numbers 1 to 8 is designed to represent the commutator, to which we shall advert further on.

In this diagram, it will be seen that the parts of the machine, although not occupying their real places, preserve at least their relative positions. The bobbins being connected as shown in the figure, and forming a continuous circle, let us suppose that the disk which carries them is made to revolve in the direction of the hands of a watch. It is easy to see that, as a consequence of the alternation of the poles of the electro-magnets and of the alternate winding of the bob-

is taken up at two points on the cylinder diametrically opposite each other by means of rubbers like those in other machines. These points of contact are represented in the diagram by two arrows and by the signs + and —. If now, we consider the machine in the position supposed by the diagram, it will be seen that, for such position, the ends of the line, *o p*, correspond to the wires 3 and 7, which, as a consequence, take, one of them a positive tension and the other a negative. But we know that these wires communicate one of them with all the plates 3, and the other with all the plates 7, and we find that the rubbers are precisely at that moment on a plate 3 and a plate 7, and are consequently taking up the current produced.

For any other position of the revolving bobbins we shall arrive at a like result: the rubber + will always be at a positive potential, and the rubber — at a negative one, and thus a continuous current will be taken up.

It goes without saying that the number of bobbins and of

magnetic fields may vary. In general, in calling n the number of revolving bobbins, and which should be an even one, that of the magnetic fields will be $n + 2$, and the number of plates of the commutator, $n\left(\frac{n}{2} + 1\right)$. The interval comprised between two bobbins will be connected with $\frac{n}{2} + 1$ plates of the commutator, and the plates of each group will have to be at equal distances from each other.

The number of magnetic fields might also be made less than that of the bobbins, and the difference might be otherwise than 2, but Mr. Hefner-Alteneck contents himself with pointing out the possibility of such an arrangement.

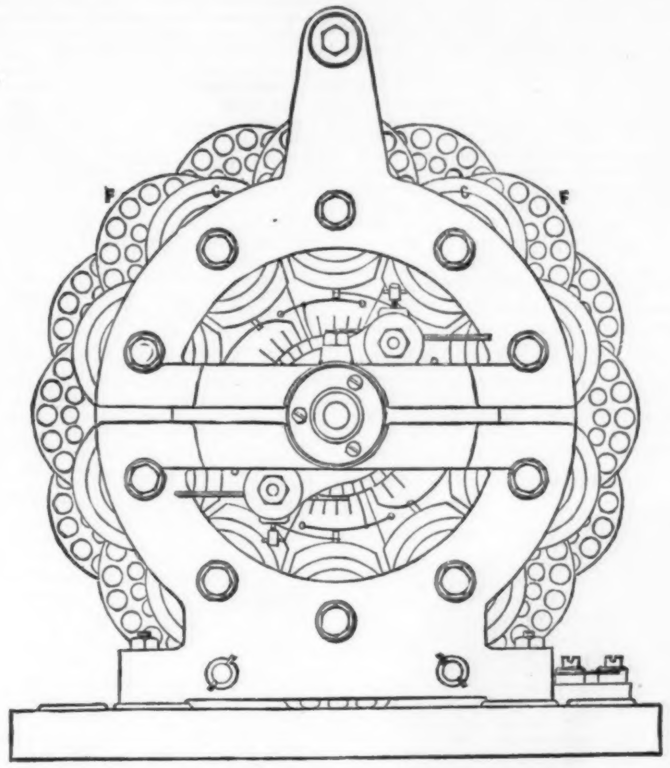


FIG. 4.—HEFNER-ALTENECK'S NEW DYNAMO-ELECTRIC MACHINE.

Finally, while preserving the same number of magnetic fields, the number of bobbins may be increased—doubled, for example. Such an arrangement presents the advantage that, in consequence of the constant reaction of the bobbins on the poles of the electro-magnets, the working of the machine is better and its running is easier. Besides, the commutator having more plates, the sparks are less. In a case like this the bobbins are arranged one above the other, but so as to only half cover each other, as shown in Figs. 3 and 4.

Fig. 5 shows a diagram of a machine so arranged. Here the bobbins are no longer connected with each other in a continuous series, but the connection is alternating, in the way shown in the figure, and the commutator in this case has 80 plates. Aside from this, the operation is the same as in the arrangement that we have just described.

Mr. Hefner-Alteneck remarks, in the very first place, that this machine presents the same advantages as the alternating machine of the Messrs. Siemens, that is: Constancy of the magnetic fields; absence of iron core in the revolving bobbins, which suppresses the changes or displacements of pole

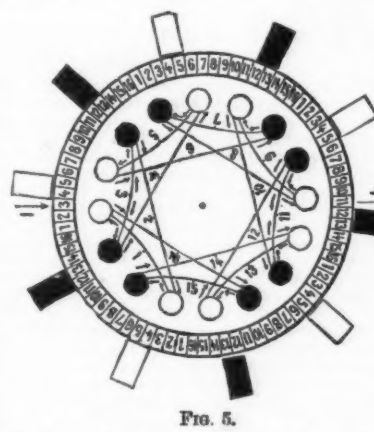


FIG. 5.

and the losses of energy consequent upon a heating of the cores; facility of winding; possibility of perfectly insulating the wire of the bobbins from the metallic parts of the machine; and finally, the slight heating of the wires in comparison with the current produced.

The best proof in support of these advantages is found in the fact that out of 600 alternating machines sold up to the present time by Messrs. Siemens & Halske, none has as yet shown a defect of insulation in the bobbins. The author next examines what advantage the continuous current machine possesses over the alternating one. After admitting that each may render services in certain definite cases, and that the alternating machine has the advantage of simplicity, he remarks that the continuous current machine will always have the superiority in the fact that it alone can be employed for certain purposes, such as electro-metallurgy, the electrolytic extraction of metals, the electrical transmission of power, telegraphy, etc.

One of the machines constructed on the principle that we have just described is capable of supplying 4 foci of 700 lamps each, with a total expenditure of 7 horse power.

INSTRUMENT FOR TESTING ELECTRICAL RESISTANCES.

WE publish a description of Captain Bucknill's arrangement of coils, galvanoscope, etc., arranged for testing, by the Wheatstone balance, resistances from 1 to 11,000 ohms, and which was in the first place specially designed by him to form a portable arrangement for testing the electrical resistances of lightning conductors and their earth connections. It is, however, equally useful for testing any resistances between the ranges specified above, and being so portable and compact it will recommend itself for general use. A battery of six small voltaic cells may or may not be embodied in the same box as desired.

The galvanoscope has a resistance of about 100 ohms and is pivoted on agate centers, and the arrangement of key and bridging coils is shown in the diagram. By plugging the hole marked EQUAL, tests of resistances can be taken from 1 to 1,100 ohms by units, and by plugging the hole marked X.TEN tests may be taken from 10 to 11,000 ohms, by jumps of 10 ohms.

The whole arrangement is contained in a box 9 in. × 4½ in. × 3½ in. Fig. 1 represents the instrument in plan, G being the galvanoscope, and A, B, C, three terminals, to which the test battery and unknown resistance are connected, the former between A and B, the latter between A and C. The bridging coils, 40, 40, 400, are permanently connected, as shown, to the outer brasses of the three in the left-hand corner, the center brass being connected to the galvanoscope and to terminal, C.

INSTRUMENT FOR TESTING LIGHTNING RODS.

Fig. 2 represents the electrical arrangement somewhat more graphically, the points marked A, B, C, corresponding to the terminals in Fig. 1.

When used for testing lightning conductors, the following stores are required in addition to the above instrument and the portable voltaic six-cell battery: Two light insulated wires, each about 100 yards long; two earth plates of thin copper, with wire soldered on; two clamps, brass, with binding screws, for connecting the leading wires to the conductors; six connectors, brass, for connecting the wires; one small file and other small stores.

A box, complete with all necessaries for testing lightning conductors, can be obtained from Messrs. Elliott Brothers, Strand. The best way to proceed in testing lightning conductors is as follows:

Balance the resistance of the leads with the ends connected, and call this wire resistance=W. Then connect one of the small test earth plates, e e^1, on the end of each lead, and, keeping them at least 20 ft. apart, give them each a good earth connection in damp soil at the bottom of a ditch, or in a canal, river, or stream, if there be such at hand; or one of the test earth plates may be lowered to the water of a well (but not to a cemented tank), and the other lead be connected to the water supply pipes or to the gas supply pipes, but not if the lightning conductor's "earth" be so made also. Then balance

$$W+e+e^1=A.$$

Now find the resistance of the conductor's earth and of one test earth, or

$$W+e+E=B.$$

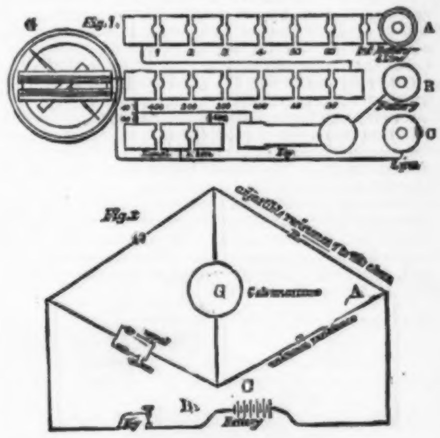
Finally, find the resistance of the other test earth and of the conductor's earth, or

$$W+e^1+E=C.$$

From these three tests the resistances of the three earths, E, e, and e^1, can be found, for

$$E=\tfrac{1}{2}(B+C-A-W)$$
$$e=\tfrac{1}{2}(A+B-C-W)$$
$$e^1=\tfrac{1}{2}(A+C-B-W).$$

As a result, E ought to balance at a very low resistance if properly made, and of sufficient surface in contact with permanent moisture. If the earth connections of two separate conductors are themselves separate but within the range of the leads, they can be tested simultaneously by the above method, only one test earth being in such a case required. Again, if a conductor possess more than one earth connection,



formed by separate plates, not too close together, and if one of these can be temporarily disconnected from the conductor, only one test earth would be necessary, and the same method pursued. In testing conductors in buildings near the sea, or near a river or canal, one test earth only is required if it can be placed in the water, a previous test having shown the resistance of such an earth plate, in salt or fresh water as the case may be.

Having found the resistances of the earths of a conductor, and their joint resistance, the whole of the conductor ought to balance at about the same figure. If not, the defects should be localized.

When testing a conductor with not more than two earths the conductivity resistance of the conductor above ground can be readily found if one of the conductor's earths can be temporarily disconnected; but this test is not necessary if the conductor's earth tests low, and the various parts of the conductor test at about the same figure.

Inaccessible conductors, such as those on chimneys, spires, etc., should be fitted with testing wires from their summits, unless they are erected as double conductors.

It is most important that every possible information, such as the depth and surface of the earth connection, the manner in which it is made, and the results of electrical tests, etc., should be recorded for future reference.

Lightning conductors should always be erected under the advice and guidance of an adept; and the electrical tests should be carefully made by an electrician, and be recorded in terms of the unit of electrical measurement.

PROSPECTIVE APPLICATIONS OF ELECTRICITY.

IT has been sometimes thought that a copper cable of enormous thickness would be required to transmit the hydraulic power of Niagara Falls to New York. Prof. Ayrton has shown that the whole power could be transmitted by a slender copper wire, provided that the wire could be thoroughly insulated. He has also shown that the only hindrance to receiving the whole power is the mechanical friction of the machines. It is therefore believed that immense machines, with continuous currents, with detached exciters or magneto-electric machines, driven very rapidly by steam engines, will hold an important place in the future transmission of energy. With such machines it would be possible to warm, to light, and to give workshops the power which is necessary to move all their machinery by means of an ordinary telegraph wire, thoroughly insulated and transmitting energy from great distances. Prof. Perry thinks that it will some time become possible to see what is going on in remote places by means of electricity.—*La Lumière Électrique.*

APPARATUS FOR EXTRACTING AMMONIA FROM GAS LIQUORS.

IN the SCIENTIFIC AMERICAN SUPPLEMENT, No. 281, of May 21, 1881, we give a description of an apparatus constructed by Dr. H. Grüneberg, for extracting ammonia from gas liquor. This apparatus appears to have been based upon the prior invention patented by Messrs. Elwert and Müller-Pack, Sept., 1874, and now assigned to Brustlein, Sury & Co., New York, of which we now present an engraving.

The patented apparatus has a long and successful past to testify in its favor, having been in use since 1874 in various large gas works, especially in Europe, where universal and entire satisfaction is expressed concerning its economy, efficiency, and purity of product.

The patented apparatus of Messrs. Elwert and Müller-Pack shows two tubular horizontal boilers (14x3,) one placed above the other, constructed so as to allow the emptying of the upper into the lower boiler by means of a connecting pipe with cock. Each boiler has the capacity of one ton of gas liquor and from 90 to 120 lb. of milk of lime. Both ends of each boiler are provided with manholes, to enable easy access for cleansing purposes, once in two or three weeks. Only the lower boiler is heated directly, and a bent tube runs up from its dome (steam drum) and down again to the upper boiler, where it continues along the bottom of same, being perforated on its horizontal part with numerous holes. From the dome of the upper boiler a pipe leads through a preliminary condenser, the condensed liquor being brought back to the upper boiler by means of a pipe, and then through a cooling worm or refrigerator, out of which a pipe conducts into a vessel provided with a safety-tube, where the vapors condensed by the cooling coil are collected, and are sucked back to the upper boiler each time the latter is charged with crude liquors and lime.

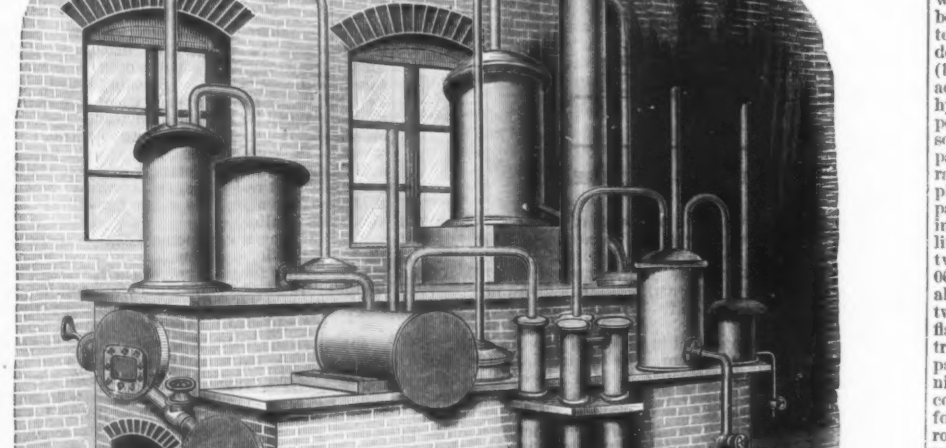
From the reservoir succeeding cooling coil a pipe enters a series of four charcoal purifiers, thence into a condensing cistern, and from this again to an additional condenser, from which a pipe opens in the air. The two last condensers are each provided with emptying pipes and safety-tubes.

The charcoal purifiers absorb all the matters, that would impure the alkali, such as the hydrocarbons, and the purified vapor enters the condensing cistern, the pure water therein absorbing the vapor until it has gained the desired percentage of ammonia. The slight residue of incondensed vapor is conducted into the last condenser, where the remainder of the ammoniacal vapor is absorbed.

After about four or five hours the lower boiler will have discharged all its ammonia, when the liquid is let out and the boiler again charged from the upper boiler, which is charged with crude liquor. During this time the purifiers may be repacked, and the liquid ammonia drawn off from the two last condensers, which must again be filled with fresh water.

Thus, from one charge, after four hours, about 200 lb. of white volatile alkali, marking 26° Baumé, are gained, perfectly pure, only needing to remain quiet several hours in order to deposit all the lime and magnesia salts caused by the water, if no distilled water is used.

For 100 lb. alkali only 27 lb. of coke are required and two men can easily run the whole apparatus. The entire process is of course more simplified and becomes more economical the larger the works, and it can safely be said that no apparatus is more efficient and gives purer products. In manufacturing on a large scale an allowance need be made for but one man per apparatus. As each apparatus can perform from five to six operations per day, a set of two apparatus can easily produce over two tons of ammonia daily.



ELWERT & MULLER-PACK'S APPARATUS FOR EXTRACTING AMMONIA FROM GAS LIQUORS.

The action of the apparatus is now as follows: The refrigerator and the two last condensers being filled with cold water, and the charcoal purifiers charged, about one ton of gas liquor and the necessary milk of lime are introduced in the upper boiler, and this boiler emptied into the lower, where the fire is started, the cock of the connecting pipe being closed again. The vapors now arising in the lower boiler will soon have expelled all the air in the apparatus, after which the upper boiler is again charged as at first, and the fire under the lower made active. The vapors now coming from the lower boiler and entering the upper through the bent tube will be forced through the perforations in its horizontal part at the bottom of the boiler, and violently agitate the fluid, thus advantageously substituting an agitator, and the vapors by rising will become purified and enriched with ammonia from the liquid.

The vapors are then conducted into the first condenser, a closed reservoir, which chiefly retains all the scum, and where also some of the ammoniacal salts are condensed, which all flow back to the upper boiler, while the concentrated vapors pass through the refrigerator or cooling worm, and thence to the second reservoir, where the products of condensation, aqueous vapor, with a portion of the hydrocarbons, free ammonia, and ammoniacal salts, are deposited, but the incondensed vapors escape and enter the charcoal purifiers.

The fluid deposited in the reservoir, which follows cooling-worm, assists toward the end of the operation, when the vapors are more fully charged with ammoniacal salts, in washing the vapors and retaining the salts, and is sucked back to the upper boiler again each time that it is charged with gas liquor, this cold gas liquor producing a vacuum in the boiler, which vacuum at the same time causes a quicker disengagement of ammonia in the lower boiler.

The application of the liquid in the reservoir has also the advantage of washing away any deposit left in the cooling coil and succeeding pipes, as well as in the pipe directly connecting said reservoir with the upper boiler.

SYNTHESIS OF AMMONIA.

MR. G. S. JOHNSON, having observed the formation of traces of ammonia while passing nitrogen gas over freshly hydrogenized copper at a red heat, was induced to make further experiments. He passed a mixture of hydrogen and pure nitrogen over spongy platinum at a low red heat. The hydrogen was produced first and passed through silver nitrate and sulphuric acid, over pumice moistened with sulphuric acid, through Nessler's reagent, and finally over the spongy platinum. The platinum having been heated to redness in the hydrogen, and the absence of ammonia proved, nitrogen was evolved from ammonium nitrite and passed through the apparatus with the hydrogen. When the mixed gases reached the hot platinum, ammonia was formed, characterized by its odor, by its rendering the Nessler reagent brown, and red litmus blue, and producing white fumes with hydrochloric acid. 5·9 milligrammes of NH_3 were produced per hour in this way. Objections having been raised to this process, on the ground that the vapor of some ammoniacal salt might be carried through the apparatus by the rapid stream of gas, Mr. Johnson made further experiments. Hydrogen was passed through the apparatus and over the spongy platinum, heating the latter until it gave off no ammonia; the platinum was then allowed to cool, and a current of nitrogen was passed through to displace the hydrogen, with the intention of heating the platinum afterward in pure nitrogen, so that the ammonia salt, if present, might be dissociated and yield its ammonia. On the admission of the nitrogen to the cold platinum, however, ammonia was produced to the amount of 24 milligrammes in an hour. To avoid all chance of error, the author repeated the experiment with nitrogen obtained from atmospheric air, but without success; nor was any ammonia produced when the nitrogen evolved from nitrite of ammonium was passed over heated copper before being brought in contact with the platinum. Hence it was to be inferred, either that the contact with the copper produced an inactive condition of the nitrogen, or that some nitrogen oxide present in the nitrogen was removed by the hot copper. The nitrogen produced from ammonium nitrite was found to contain some nitric oxide, to remove which it was passed through ferrous sulphate, and then, to test its purity, through a tared tube containing freshly reduced copper heated to redness. When the gas has passed over a sufficient length of the ferrous sulphate, the tube acquired no increase of weight. This nitrogen, entirely freed from oxide, was now passed over cold spongy platinum, mixed with hydrogen, and 3 milligrammes of ammonia were produced in an hour. But when the mixed gases were passed over heated asbestos before reaching the platinum, no ammonia was produced until the asbestos-tube had cooled considerably. Hence the author concludes that nitrogen, like phosphorus, may exist in two states, active and inactive, the latter produced by exposure to heat.—*Journ. Chem. Soc.*

NITROUS ACID DURING THE EVAPORATION OF WATER.

WARINGTON has submitted to the test of careful experiment Schönbein's statement that whenever pure water or an alkaline solution is evaporated, nitrite of ammonium is produced, and concludes that "it is undeniable that pure water, if evaporated to a small bulk, by ordinary means, will generally be found to contain nitrous acid." A sample of rain water which gave no reaction to the metaphenylenediamine test, after concentration to one quarter of its bulk, showed the reaction distinctly. A liter of distilled water, with 5 c.c. lime water, evaporated to a small volume over a Bunsen burner, gave a strong reaction. The importance of this result, with reference to the determination of nitrites in natural waters, led to an investigation of the cause of this result.

First it appeared that a liter of distilled water, evaporated in a retort, either exhausted or at atmospheric pressure, gave no reaction for nitrous acid, and hence proved the air to be the source of the contamination. Another liter with 5 c.c. lime water, was evaporated in a glass basin 6½ inches in diameter over a Bunsen rose burner. The reaction given was strong and corresponded to about 0·05 mgrm. of nitrogen. Since a second similar evaporation, conducted with steam, gave only 0·004 mgrm. nitrogen, it was clear that the nitrous acid had mainly come from the combustion of the gas used as fuel. But still even in the residue obtained with steam, the rose-color appeared. That this came directly from the air of the room was shown by placing a second basin of distilled water by the side of the first during the evaporation. After twenty-four hours a full rose tint was developed; and this without any sensible evaporation. For extremely accurate work, water then must be evaporated in close vessels; but for ordinary purposes, the concentration may be effected in a steam bath.

Warington gives in his paper some experiments made with the naphthylamine test for nitrous acid, proposed by Griess, which show an extraordinary delicacy. The solution to be tested was slightly acidified with hydrochloric acid and a few drops of an aqueous solution of sulphanilic acid and of a similar solution of naphthylamine hydrochloride were added. The nitrous acid if present forms a diazo-compound, which the naphthylamine converts into a body having a beautiful rose color. The tests for delicacy were made in test tubes, the column of liquid being about three inches deep. To 10 c.c. of the solution were added one drop of HCl (1 : 4), one drop of an early saturated solution of sulphanilic acid and one drop of a saturated solution of naphthylamine hydrochloride. The standard solution was made with potassium nitrite prepared from pure silver nitrite. With a solution of 1 part of nitrogen as nitrous acid in 1,000,000 parts of water an immediate pink color appeared which rapidly became deep ruby red; in 10,000,000 parts, at once a pink, and at the end of an hour a full rose; in 100,000,000 parts a pink tinge in six minutes, and a pale pink in an hour; in 500,000,000 parts (1 c.c. of the millionth solution in a half liter of water) showed a pink tinge before two hours, and in twenty-four hours the three inch column showed it; 1,000,000,000 parts, using ten drops of the reagents, showed an alteration of tint in two hours, and a distinct pink color in twenty-four hours. In the last two experiments similar flasks to which no nitrite had been added were similarly treated, but without result. During the reading of the paper in the Chemical Society's room, the presence of nitrous acid in the air was shown by exposing 20 c.c. of water containing the test, to the atmosphere there in a basin for four hours. On pouring it into a cylinder, it had become rose-pink, as was seen on comparing it with a similar cylinder which had been closed with a watch glass. In the open air at the Rothamsted farm, nitrous acid was detected by this air test. In six days the reaction appeared in water exposed to this air, and in twenty-seven days it contained one part of nitrogen in 15,000,000. In rain water the naphthylamine test readily shows nitrous acid, except when the rains are exceptionally heavy.—*J. Chem. Soc.*

NEUTRAL OXALATE OF POTASSIUM.

By E. B. SHUTTLEWORTH.

THE rapid dry-plate processes in photography, which are at present exciting considerable attention among the more advanced classes of those engaged in the art, have created a demand for neutral potassium oxalate that cannot be supplied through the ordinary trade channels. The writer has frequently been asked for this salt, as doubtless have many of the readers of the *Journal*, and as the preparation is simple, involving no special apparatus, a few notes on the subject may prove opportune.

There are three oxalates of potassium known to chemists—the *neutral* salt to which this paper refers, and which contains two atoms of potassium to one molecule of acid; the *binoxalate*, the ordinary *salt of sorrel* of the drug stores, and that which is found in many plants, containing one atom of potassium to one of acid; and the *quadroxalate*, a salt not frequently prepared or used, in which the proportion of potassium and acid are as 1 to 2.

The neutral salt is the only one used in photography. It crystallizes in rhombic prisms, is stable in the air, contains two molecules of water of crystallization which may be driven off by heat, and is soluble in about three times its weight of cold water.

It is evident that the easiest mode of preparing this salt is by neutralizing a solution of carbonate of potassium by oxalic acid. Some have recommended that the ordinary salt of sorrel, *sal acetosella*, be rendered neutral by the addition of the carbonate, but this is certainly a roundabout and expensive plan, not only as involving the use of more costly material, but unnecessary evaporation. The most expeditious method will be found to be as follows:

Dissolve a quantity—say one pound—of carbonate of potassium in an equal weight of cold water, decanting the clear solution from any undissolved sediment, if such should remain. This residue consists of potassium sulphate or silicate, and is commonly present in the ordinary salts of tartar of commerce. Put the clear solution in an enameled iron, porcelain, or wedgwood dish, add a quantity of water equal to that first employed, and heat to the boiling point. Add carefully, and by small portions, avoiding mishap by effervescence, sufficient powdered oxalic acid to neutralize the carbonate, testing carefully toward the close with test paper. If necessary filter the solution while hot, and set

aside to crystallize. A fresh crop of crystals may of course be obtained by evaporating the mother liquor.

The quantity of oxalic acid required cannot be definitely stated, as both acid and carbonate are generally impure; but theoretically, 174 parts of carbonate should require 90 of acid, and produce 202 of neutral oxalate. The product will practically be always considerably less than this, seldom equaling more than the weight of the carbonate employed.

As has been stated, the neutral oxalate is soluble in about three times its weight of water, and as photographers use a saturated solution, there is no reason, if time be an object, why a liquor should not be prepared extemporaneously, or at least that the operation of crystallization might not be omitted.

I have found that the specific gravity of such a solution is at ordinary temperatures, 1·220, and that ten ounces of the salt, when dissolved, measure twenty-six fluid ounces. Such a solution, except made with distilled water, will, of course, require filtering, as the lime present in ordinary water is precipitated as oxalate.—*Canadian Pharm. Journal.*

SOME CHEMICAL REAGENTS.

Translated by M. BENJAMIN, Ph.B., F.C.S.

1. HYDROCHLORIC OR MURIATIC ACID. (HCl.)

Preparation.—*a.* Either by pouring sulphuric acid on common salt and passing the HCl produced through distilled H_2O, or (*b.*) by distilling the commercial muriatic acid and diluting it with H_2O till the sp. gr. of 1·12 is obtained.

Tests.—*a.* It must be colorless and must not leave any residue on evaporation; *b.* if it decolorizes liquids colored blue with iodide of starch then it contains H_2SO_3; *c.* if it colors a mixture of potassium iodide and starch blue, then it contains free chlorine; *d.* if it gives a precipitate with barium chloride, then it contains H_2SO_4; *e.* if it is colored yellow it contains iron.

Uses.—*a.* It dissolves most minerals, with the exception of the silicates; *b.* it converts some of the metals into chlorides with the evolution of H gas; *c.* it converts sulphides into chlorides with the development of H_2S; *d.* it also converts many of the oxides into chlorides; with the peroxides, chlorine is set free; *e.* salts with insoluble and volatile acids are changed into chlorides with the separation of the acid; *f.* with NH_4HO, it forms a white cloud in the air.

2. NITRIC ACID. (HNO_3.)

Preparation.—*a.* Either by the distillation of potassium or sodium nitrate with H_2SO_4, or (*b.*) by the distillation of the crude nitric acid, the hydrochloric acid having first been removed by precipitation with $AgNO_3$.

Tests for purity.—*a.* If $BaCl_2$ produces a cloudiness it contains H_2SO_4; *b.* a precipitate with $AgNO_3$ shows the presence of chlorine; *c.* no residue should remain after evaporation on platinum foil.

Uses.—*a.* As a solvent for minerals, excepting the silicates; *b.* as a solvent for certain metals and sulphides; *c.* as a solvent for many of the oxides; *d* as an oxidizing agent, converting the oxides into peroxides; *e.* especially desirable as a solvent for substances in which chlorine is sought after.

3. AQUA REGIA.

Preparation.—By mixing 3 parts pure HCl with one part HNO_3.

Uses.—*a.* It is the best solvent for metals, with the exception of such as form insoluble compounds with chlorine; *b.* especially used for the dissolving of gold and platinum; *c.* for the decomposition of different sulphides, as for instance, cinnabar.

Action:

$$2HNO_3+6HCl=4H_2O+2NOCl_2+Cl_2.$$

The free chlorine is the essential solvent.

4. SULPHURIC ACID. (H_2SO_4.)

Preparation.—*a.* Either in lead chambers from SO_2, steam and NO_2 (see Sulphur), or (*b.*) English H_2SO_4 is heated with oxalic acid, by means of which all N_2O_3 and N_2O_5 are removed, then sodium chloride is added and heat applied, driving off the HCl and at the same time any arsenic that may have remained in the crude acid.

Tests.—*a.* It should be colorless; *b.* it must not color a solution of $FeSO_4$ red or brown; this would indicate the presence of HNO_3; *c.* it must not when mixed with the starch paste, color a solution of potassium iodide blue; this would show the presence of HNO_2; *d.* it should give, with clean zinc and water, a flame of hydrogen, which will not leave any stain on porcelain.

Uses.—*a.* For the displacement of weak acids from their compounds; *b.* for the detection and precipitation of barium and lead salts from their solutions; *c.* for the disengagement of H_2S gas.

5. ACETIC ACID. ($H.C_2H_3O_2$ or $H\bar{A}$.)

Preparation.—From acetates by decomposition with H_2SO_4 and distillation.

Tests.—*a* Should leave no residue on evaporation; *b.* baryta water does not produce a cloudiness (H_2SO_4); *c.* indigo solution is not discolored (HNO_3).

Uses.—*a.* For acidifying solutions, when the use of the strong mineral acids is to be avoided; *b.* for the separation of aluminum and iron phosphates (insoluble) from calcium and magnesium phosphates (soluble); *c.* for the solution of certain albuminoids; *d.* for the precipitation of certain albuminoids.

TARTARIC ACID. ($H_2.C_4H_4O_6$ or $H_2\bar{T}$.)

Preparation.—*a.* By dissolving chemically pure tartaric acid in distilled water, or (*b.*) by the decomposition of calcium tartaric with H_2SO_4; the resulting calcium sulphate is insoluble, and the tartaric acid is extracted with H_2O.

Tests.—It is completely soluble in alcohol.

Uses.—*a.* For the detection of potassium in its solutions; *b.* for the separation of the Fe_2O_3, MnO, and Al_2O_3 from other substances, the precipitation of which is effected by tartaric acid.

7. POTASSIUM AND SODIUM HYDRATE. (KOH and NaOH.)

Preparation.—By dissolving pure KOH or NaOH in distilled H_2O.

Tests.—They are generally contaminated with traces of HA, H_2SO_4, H_3PO_4, and almost always contain SiO_2 and Al_2O_3; the two latter are especially objectionable. *a.* If it is desirable to detect them, the substance is saturated with HCl and evaporated to dryness, then moistened with HCl and dissolved in H_2O; the residue is SiO_2; *b.* if in the filtrate from the SiO_2 a precipitate is obtained with $(NH_4)_2CO_3$, Al_2O_3 is present.

Uses.—*a.* For the expulsion of NH_3 from its combinations; *b.* for the dissolving of many salts (as, for instance, lead chromate); *c.* for the decomposition of most salts with precipitation of their bases, that are insoluble in H_2O; *d.* for the separation of Al_2O_3 from Fe_2O_3; the former is soluble in an excess of KOH or NaOH, while the Fe_2O_3 is insoluble.

8. AMMONIUM HYDRATE. (NH_4HO.)

Preparation.—By treating any ammonium salt with KOH, NaOH, or CaO, the liberated NH_3 is passed into distilled H_2O.

Tests.—*a.* Must be colorless; *b.* should leave no residue on evaporation; *c* must not produce a turbidity with lime water (indication of CO_2); *d.* should not give any cloudiness with either $BaCl_2$ or $AgNO_3$.

Uses.—*a.* For neutralizing acid solutions; *b.* for the separation of many metallic oxides; *c.* for the separation of many metallic oxides, some of which are soluble in excess, others not; *d.* especially for the separation of Fe_2O_3, which is precipitated from CaO and MgO (which are not precipitated); *e.* those chlorine compounds, which on account of the presence of organic substances, cannot be detected by means of $AgNO_3$, are treated with H_2SO_4; if they contain chlorine white clouds will be produced from the vapors; when they are brought near to objects moistened with NH_4HO.

9. POTASSIUM CARBONATE. (K_2CO_3.)

Preparation.—By the purification of crude potash.

Uses.—In the dry state for the decomposition of silicates, aluminates, etc., by employing it as a flux in fusions.

10. SODIUM CARBONATE. (Na_2CO_3.)

Preparation.—By the purification of crude, calcined soda.

Uses.—*a.* For the decomposition of the silicates, and also iron and aluminum phosphates; *b.* for the detection of humic acids.

11. AMMONIUM CARBONATE. ($(NH_4)_2CO_3$.)

Preparation.—By the sublimation of a mixture of sal ammoniac and chalk.

Tests.—*a.* Should leave no residue on evaporation; *b.* after supersaturation with HNO_3 it should not be rendered turbid by

1. $AgNO_3$ (HCl)
2. $BaCl_2$ (H_2SO_4)

Nor by H_2S.

Uses.—*a.* It precipitates most of the metallic oxides and earths; *b.* as compared with other reagents, as, for instance, Na_2CO_3, it has the advantage that in its use no fixed salts enter the solution; *c.* of the substances precipitated by ammonium carbonate some are soluble in excess of the precipitant, and hence many errors are liable to occur; *d.* it is especially adapted for the precipitation of BaO and CaO, and their separation from MgO.

12. SILVER NITRATE. ($AgNO_3$.)

Preparation.—By dissolving pure silver in nitric acid.

Tests.—After the silver has been completely removed by HCl the filtrate should leave no residue on evaporation.

Uses.—*a.* For the detection and estimation of every trace of chlorine, bromine, and iodine compounds; *b.* also for the detection of the phosphates of the alkalies; *c.* many of the insoluble silver salts have characteristic colors (for instance, silver chromate), and so indicate without doubt the composition of the substance under examination.

13. BARIUM CHLORIDE. ($BaCl_2$.)

Preparation.—By heating powdered heavy spar, mixed with charcoal, the cooled mass is treated with HCl, the BaS decomposed, and the resulting $BaCl_2$ dissolved and filtered.

Tests.—*a.* With an excess of H_2SO_4, $BaCl_2$ is precipitated; the filtrate should leave no residue on platinum foil after evaporation; *b.* it must not alter vegetable colors; *c.* no coloration is produced with either H_2S or $(NH_4)_2S$.

Uses.—*a.* Especially for the estimation of H_2SO_4; *b.* for the detection and separation of different acids, as it forms with some soluble and with others insoluble compounds.

14. BARIUM NITRATE. ($Ba(NO_3)_2$.)

Preparation.—In the same way as the previous reagent, except that HNO_3 is used instead of HCL.

Tests.—It should not produce any turbidity with silver solution ($AgNO_3$).

Uses.—It is used in cases where No. 13 cannot be employed.

15. MAGNESIUM SULPHATE. ($MgSO_4$.)

Preparation.—By dissolving chemically pure magnesium sulphate in distilled H_2O.

Tests.—It must not give a precipitate with NH_4HO.

Uses.—Especially employed for the detection of P_2O_5 when in combination with alkalies, as it precipitates it in the presence of NH_4HO from aqueous solutions as basic ammonium magnesium phosphate.

16. AMMONIUM MOLYBDATE. ($(NH_4)_2MoO_4$.)

Preparation.—By digesting the MoO_3 obtained from molybdenum sulphide with NH_4HO.

Tests.—On adding HNO_3 and heating, it must not turn yellow, as this would indicate P_2O_5.

Use.—For the detection and determination of P_2O_5 when in combination with CaO, MgO, Mn_2O_3, and Fe_2O_3, as the MoO_3 forms with P_2O_5 and NH_4HO in the presence of an excess of MoO_3, a compound which is with difficulty soluble in H_2O and acids.

17. DISODIUM HYDROPHOSPHATE. (Na_2HPO_4.)

Preparation.—By supersaturating Na_2CO_3 with pure H_3PO_4.

Tests.—*a.* If barium or silver solutions produce a precipitate, it must disappear completely on the addition of HNO_3; *b.* on heating with NH_4HO it must not become turbid.

Uses.—*a.* It throws down the metallic oxides; *b.* it is especially employed for detecting Mg in ammoniacal solutions; after its separation from Ba and Ca; the Mg is precipitated as $(NH_4)_2Mg_2P_2O_8$.

18. AMMONIUM OXALATE. ($(NH_4)_2C_2O_4$ or $(NH_4)_2\bar{O}$.)

Preparation.—Well crystallized oxalic acid is dissolved in H_2O, saturated with NH_4HO, and crystallized; the salt thus obtained is dissolved in distilled H_2O; 1 part of the salt to 24 of H_2O.

Tests.—*a.* It should leave no residue after evaporation on platinum foil; *b.* H_2O and NH_4HO should not produce any turbidity.

Uses.—*a.* Especially for the detection and estimation of CaO; *b.* barium, lead, and other oxides are also precipitated by $(NH_4)_2C_2O_4$.

19. SODIUM ACETATE. ($NaC_2H_3O_2$, $Na\bar{A}$.)

Preparation.—By dissolving Na_2CO_3 and neutralizing with $H\bar{A}$, then evaporating and crystallizing; the salt thus obtained is dissolved in the proportion of 1 to 10 parts of H_2O.

Tests.—It should not give a yellow coloration with $(NH_4)_2MoO_4$ on heating (P_2O_5).

Use.—For the precipitation of ferric phosphate from its hydrochloric acid solution, as this salt is insoluble in $H\bar{A}$.

20. PLATINUM CHLORIDE. ($PtCl_4$.)

Preparation.—By boiling platinum scraps with aqua regia.

Test.—Evaporated to dryness over a water bath, it should give a clear solution with alcohol.

Uses.—*a.* Delicate reagent for potassium salts, as it forms with potassium chloride an insoluble double salt; *b.* it is also used for the determination of ammonium, as it forms the insoluble ammonium platinum chloride.

21. POTASSIUM SULPHATE. (K_2SO_4.)

Preparation.—By dissolving pure K_2SO_4 in distilled H_2O.

Use.—For the separation of barium and strontium.

22. POTASSIUM DICHROMATE. ($K_2Cr_2O_7$.)

Preparation.—One part of pure $K_2Cr_2O_7$ is dissolved in 10 parts of H_2O.

Uses.—*a.* It forms with metallic oxides, almost insoluble chromates of different colors; *b.* especially employed for the detection of lead.

23. POTASSIUM ANTIMONATE. ($K_2Sb_2O_6$.)

Preparation.—By the fusing of pulverized antimony with KNO_3, and extracting with H_2O.

Use.—For the precipitation of sodium salts, which forms, with Sb_2O_5, almost insoluble compounds.

24. AMMONIUM SUCCINATE. ($(NH_4)_2C_4H_4O_4$.)

Preparation.—By the saturation of succinic acid with NH_4HO.

Use.—For the separation of Fe_2O_3 from MnO, giving rise to an iron succinate, of a cinnamon brown color.

25. POTASSIUM FERROCYANIDE. (K_4FeCN_6.)

Preparation.—The pure yellow prussiate of potassium of commerce is dissolved in 12 parts of H_2O; this salt may be prepared by carbonizing animal refuse (excepting bones) and fusing it with K_2CO_3 and Fe. The fused mass is comminuted and treated with H_2O; the resulting yellow solution is crystallized.

Uses.—*a.* With most of the metals it gives insoluble colored precipitates; *b.* especially employed for the precipitation of Cu as a red brown copper ferrocyanide; *c.* for the precipitation of iron ferrocyanide (Prussian blue); these precipitations are due to the fact that the potassium is displaced by the corresponding metal.

26. POTASSIUM FERRICYANIDE. (Red Prussiate.) ($K_6Fe_2CN_{12}$.)

Preparation.—Is obtained by passing chlorine gas through a concentrated solution of the potassium ferrocyanide until the yellow color is changed to red. It is then crystallized, and one part of the salt thus obtained is dissolved in ten parts of H_2O.

Tests.—It must not give a blue color with ferric chloride.

Uses.—It is the principal test for the proto salts of iron, with which it forms Prussian blue, as shown in the following reaction:

$$K_6(Fe_2CN_{12})+3FeSO_4=Fe_5CN_{12}+3K_2SO_4.$$

DISAPPEARANCE OF NITRATES BY DECOMPOSITION IN THE DARK.

IN plants which grow in the dark, although there is a regular organization and development of stalks, roots, and appendages, there is a persistent elimination of a portion of the material which was contained in the seed. The tissue of the organs which are developed under a shelter from light is firm and strongly impregnated with a liquid which has a sensibly acid reaction. The cotyledons are, therefore, provided with the principles which are necessary for the life of the embryo; but nocturnal vegetation is unable to fix the carbon of the carbonic acid which is in the air. Boussingault has experimented in order to find whether this impotence extends to the fertilizing substances which the roots commonly draw from the soil; if, for example, nitrogenous compounds, such as the nitrates and the ammoniacal salts, are assimilated. He immediately found that if a measured quantity of these salts is added to a sterile soil a considerable portion disappears entirely, and only a part of the quantity is found in the growth. He therefore concludes that a soil which had been rendered entirely sterile contains traces of organic substances after vegetation in the dark. These substances are probably due to an excretion from the root, which exercises a destructive action upon the acid of the nitrates that were added to the soil.—*Ann. de Chim. et de Phys.*

THE BRIN PROCESS FOR OXYGEN.

BOUSSINGAULT first discovered the property of barytes to absorb the oxygen of the air at a certain temperature and to restore it at a higher temperature. Great practical difficulties have arisen, from the fact that the barytes rapidly become inert and require to be revived, and that the oxygen is usually very impure. Messrs. Brin Bros. heat the commercial sulphate of barytes, in special furnaces, with 25 per cent. of carbon, in order to form a sulphuret, which is dissolved in water and treated by nitric acid. A nitrate is thus obtained which, when calcined in a special furnace, gives a caustic barytes at a cost of 2½ francs per kilogramme (19 cents per pound). Then, by a proper preparation of the air in order to render it easily decomposable, by the use of pumps and ventilators or aspirators in order to facilitate the peroxidation of the barytes and extract the oxygen afterwards, and by the employment of special pyrometers for the automatic regulation of the furnace temperature, they are already able to produce oxygen, of great purity, at a cost of 62 centimes per cubic meter ($3.50 per 1,000 feet). They think that by manufacturing upon a large scale the cost could be reduced about one-fifth of this amount.—*Chron. Indust.*

OZONE AS A CAUSE OF THE LUMINOSITY OF PHOSPHORUS.

VARIOUS writers, especially Joubert, have called attention to the connection of the phenomena of phosphorescence with ozone. To learn something of the nature of this connection, Chappuis has studied the effect of ozone upon the luminosity of phosphorus in the presence of oxygen. Fourcroy had long ago observed that in pure oxygen, at a temperature of 15° and under atmospheric pressure, phosphorus is not luminous in the dark. Chappuis now finds that under these conditions a bubble of ozone introduced into the bell jar produces the phosphorescence, though only momentarily, the ozone being destroyed. Moreover, it is not the vaporization of the phosphorus which determines the phosphorescence, but the combustion of this vapor, the entire space occupied by the oxygen at first appearing luminous, the solid becoming so only after all the vapor has been burned by the ozone. Two cylinders, one containing air, the other pure oxygen, were inverted over two dishes containing iodide of potassium and starch solution. A fragment of phosphorus was plunged into each gas, in contact with the liquid. In the first, the phosphorus became luminous and the solution became blue. In the second neither phenomenon appeared. Whenever the phosphorescence appeared, ozone was present; and whenever ozone was absent there was no luminosity. Moreover, the author calls attention to the fact that certain bodies which have the power of preventing this luminosity of phosphorus are precisely those bodies which destroy ozone or are destroyed by it. Oil of turpentine, for example, which is the most active, destroys ozone completely. In a balloon containing air, phosphorus, and turpentine, a bubble of ozone produces light for a second only, the ozone being destroyed by the turpentine, but burning a part of the phosphorus vapor also. On adding the ozone the luminosity extends throughout the space, and at last the solid phosphorus only remains luminous. Hence the author regards the production of the luminosity of phosphorus in oxygen as one of the most delicate of the reactions for ozone, and purposes to employ it in subsequent researches.—*Bull. Soc. Ch.*

THE SQUID OF THE NEWFOUNDLAND BANKS IN ITS RELATION TO THE AMERICAN GRAND BANK COD FISHERIES.

By H. L. OSBORN.

THE broad continental plateau which fringes our eastern coast, rises in many places near to the ocean's surface, and forms shallows known in sailor language as "banks." These banks have, on the average, a depth of thirty fathoms, though in some places but seven or eight fathoms, and are a favorite resort of the several species of our most important food fishes, visiting the places to prey upon the many forms of marine invertebrates covering these favoring spots in most luxuriant profusion. In most cases the banks are not extensive, not more than from ten to twenty miles in length, but this rule finds a notable exception in the case of the Grand Bank, off Newfoundland. This shoal is in shape nearly an equilateral triangle; its base is two hundred and seventy miles long, running east, north-east, and lying somewhat east of south-east from the island. This northern edge, furthermore, is sixty miles distant from land, and the intervening water has an average depth of eighty-five fathoms. The edge of this shoal is very clearly defined, the water along the northern limit falling suddenly, in the distance of only a mile or two, from thirty to sixty fathoms, while, on the other sides, the descent is frequently very rapid from thirty to one hundred and eighty fathoms. It has been noted as the most favorable grounds for the capture of the cod since before 1740, at which time seventy vessels from Gloucester alone scoured the banks, and since which time the number has fluctuated, till at present more than four hundred schooners are engaged in the pursuit. The problem of bait has always been a troubling one to this enormous fleet. I am told that in early days salt bait of clams or fish was in universal use, but of late some sort of fresh bait has seemed a necessity, and the squid has become the favorite form. This they are forced to procure at Newfoundland, and they have thus opened a new traffic to the people of the island, and caused, too, at times, much hostility and ill-feeling.

During the summer and fall of 1879, I had the opportunity of spending three months on a codfishing schooner, for the purpose of making zoological collections, and also of studying the men and their methods: this gave me a chance to visit a large number of harbors, and to study in some detail the matter of bait.

The bait used during the latter part of the year is the squid; not *Loligo pealii*, Les., the common form of the ocean waters south of Cape Cod, but *Ommastrephes illecebrosa*, Quatr., a more northern species, readily distinguished by its movable eyelids. So many good descriptions and figures of this species are in the reach of every one, that any description of the creature is unnecessary in this place. For accurate description of the wonderful changes of color in the integument, I would refer the reader to Professor Verrill's account.*

The squid does not appear early in the year, during which time the herring, *Clupea harengus*, and the capelin, *Mallotus villosus*, are used, but "strikes" late in June or early in July, touching first upon the southern points of the island. The natives and the fishermen agree in the opinion that the squid migrates steadily northward during the season, appearing first in the northern harbors two weeks later than in the southern, and finally lingering at northern points in the island after they have entirely disappeared from those further south. One is induced, moreover, to believe in a migration among the squid, from the intermittent manner in which they are captured. At one time they are taken as fast as they can be hauled in while, again, scarcely any can be caught. Furthermore, captures of different times will often average very differently in size, indicating that those of the same ages move in the same schools, and that one school is replaced by another. Thus on one day we secured a large number of very large squid, the largest measuring 290 mm. and the average 265 mm. from base of tentacles to tip of tail, but on the following day could obtain none whose length was greater than 190 mm.

Evidence is not wanting to show that the squid do sometimes occur on the Grand Banks. Vessels are reported to have caught their bait while at anchor there, and yet I can but regard this as the exception, and I believe that the habit of the squid is to remain during the summer quite near shore. In examination of the stomach contents of the cod, I saw nothing to indicate the squid's presence on the banks. This to be sure is negative evidence, yet it carries some weight.

* "Invertebrates Vineyard Sound," pp. 442, 443, 1874.

The sole mode of capture of the squid is called "jigging," a term derived from, and descriptive of the process. The only gear is a peculiar hook called a "jig," and a couple of fathoms of "mackerel" line. No bait is employed. The jig is of lead, two inches or thereabouts in length, armed at its base with sharply pointed unbarbed pins radially arranged, and curving upward and outward. The jigging is conducted in water of from eight to ten feet, usually from small boats, but occasionally from the vessel's side. The jig is allowed to sink nearly to the bottom, where it is kept constantly vibrating up and down, till the squid is felt upon it. Frequently two jigs are managed, one in each hand.

In its mode of taking the hook, the squid differs from any other animal I have ever met. In place of a nibble followed by a snap, with the subsequent struggle for escape, there is a sensation as of some one grasping the hook with his fingers. The squid does not use his mouth in "biting," but merely clasps his tentacles round the jig. The pain from the sharp pins doubtless induces him to escape instantly, but the fisherman who is constantly jerking the jig up and down, pulls in as rapidly as possible, entangling the squid's arms among the pins, and drawing him through the water so fast that escape is impossible.

The instant he emerges from the water he contracts his body, discharging through his siphon a jet of salt water. This is followed by a sucking in of the air by successive respiratory acts, till in its middle portion his cylindrical body has become almost spherical. By a second contraction, the squid now ejects from his siphon a stream of his black, inky secretion. He will usually make one or two or more contractions in an effort to escape, after which he becomes resigned. Not infrequently it happens that the luckless wight has not the squid unhooked before the inky discharge, and may have this sent at himself, since the siphon points away from the animal and upward. I have often seen a fellow struck full in the face by the inky stream, which event was invariably followed by a stream of almost as black abuse intended for the benefit of the squid.

The squid is unhooked by simply turning the jig upper end downward, when he readily drops off. For the most part they are caught wholly by the natives, the Americans usually perferring to look on or to find amusement ashore, though in some cases the fishermen themselves jig also. This, however, is apt to excite jealousy among the natives, or even such hostile feelings at times as to induce them to forcibly prevent the Gloucester men from catching their own bait, or even to purchase it in their harbor. The scene when the squid are thick is really exciting, the streams rising here and there, in twenty directions at once, point out the rapidity of the catch, and the monotonous noise of the squirt is only varied by an occasional murmur of discontent from this or that unfortunate as he lifts his querulous voice. In the dull time most of the jiggers drop away, leaving only those most long-suffering ones, but they return pell-mell if the frequent squirt shall indicate renewed activity.

The purchase of the squid is made at a certain price per hundred, this being usually thirty-five or forty cents, though occasionally falling as low as twenty-five cents. The price but rarely rises above forty cents, for the profits are too small to permit of its reaching a much higher figure. The number used by a single vessel in only two months is astounding. Our vessel, a small one, made three "baitings," fishing each time about two weeks, and used in that time 80,000 of the squid. A larger vessel, carrying two more men, would in the same time have probably used over 100,000. As to the whole number of squid used in a single season by Americans alone, I have not sufficient statistics to give an accurate statement; it would, however, be reckoned high in the tens of millions.

In delivering his squid, the native accurately counts them, taking up five at a time and throwing out one at every hundredth for tally. And in this the native stupidity appears, for had he ten thousand to dispose of, he would handle over the entire number rather than estimate their value by weighing or measuring. Since they must be each paid separately, and never have themselves any change, the skipper is forced to carry with him a large supply of fractional pieces, so that he will not unfrequently have one or two hundred dollars on board in five, ten, and twenty cent pieces of Newfoundland currency, having secured them at some of the larger towns by a draft on his vessel.

It is very strange that, though such an enormous and often pressing demand for the squid exists, no enterprise has ever been undertaken for facilitating its supply with the least possibly delay. A vessel is by no means infrequently delayed two or three weeks, and in the course of her search forced to visit harbor after harbor till she had coasted alongshore three or four hundred miles. To such an extent is this true, that the vessel will often spend more time in the search for bait than it afterward takes to use it up. This trouble might be obviated with the greatest ease, for in time of plenty, the squid might be preserved in ice to be drawn upon when, in a lull, the catch was not large enough to supply the incoming vessel, and the vessel could then return to her fishing ground with the loss of but a single day. Nor would there be any difficulty in procuring ice in Newfoundland during the winter, nor any danger that the bait could not find a market, for the fishermen would not be long in advertising such a place both far and wide. Even if there were some means of communication between the harbors the trouble would be far less than at present; it would be utterly impossible to drive a horse in most directions, and there is scarcely a telegraph line in the island. Hence when the fisherman seeks bait he must cruise about till he finds it, and at present he spends twice as much time in sailing and bait-hunting as in the actual work of fishing.

When at night the day's catch is brought on board, the men proceed to preserve the squid either by salting them or by placing them in ice. In case the season is growing late the skipper has several thousand well salted and stowed for use when fresh squid can no longer be had. But most of the squid are sandwiched in layers of two or three deep between layers of finely broken ice in bait bins in the vessel's hold. Twenty-five or thirty thousand are thus cared for at a "baiting," and will keep in fit condition for use from two to three weeks. In using them each squid is cut into about five pieces, and one piece is used for each hook. The hooks are usually well cleaned by the carnivorous gastropoda which infest the banks and by the various fish which are not caught, so that the same piece of squid is rarely used on two occasions. The fish do not bite with the same avidity at the last of the baiting, the fresh bait securing by far the most fish. The salt squid is nearly useless in the summer and early fall, but late in October I am told that they are used with considerable success.

In what I have said, I have made no mention of any use of the squid save by the Americans, but I cannot leave the subject without a brief mention of other uses fully as important as this. The Newfoundlanders themselves use an enormous number, both for bait in their shore fisheries, and as a fertilizer for their land. I have been assured, also, that they are good to eat, but though food materials are not abundant on the island, they are not put to this use there so far as I know. The French, moreover, have very extensive fisheries on the Newfoundland coast fully as important as the American, I should judge, their vast size being insured by a bounty offered by the government to fishermen, and by the practice of re-enforcing the numbers from among the national convicts. These French vessels do not seek their own bait as is the case among Americans, but are supplied by vessels, which make a specialty of collecting bait, and spend their time alternately in its search and in its delivery. To a very large extent, I understand, the French use salt bait, they being content with small catches, while the American is disgusted unless he makes fine hauls every day.

And having thus seen the present importance of this industry, does it not seem strange that it has existed but ten or fifteen years, and that previously, for one hundred and fifty years, innumerable fish were captured with salt bait, or the viscera from the catch of the day before? This fact illustrates a most striking characteristic of the American fisherman—the strong conviction that the fish have decided preferences in the matter of bait and will not take any kind which is out of season. He will often spend the entire month of August in fruitless search rather than use herring or capelin and gain but a moderate success; nor could any argument convince him that a codfish would bite at a salt clam while "the fleet was using squid."—*American Naturalist.*

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